CONTENTS

FEATURES

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.

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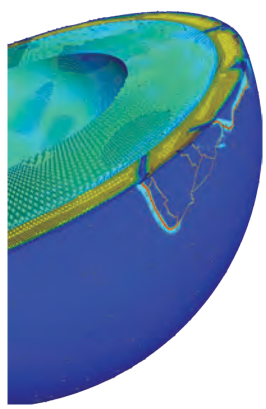
On the cover: Omar Ghattas, joint professor at the Jackson School and the Department of Mechanical Engineering and director of the university's Center for Computational Geosciences, helped pioneer a new computational model of plate tectonics. His work with collaborators at UT Austin and Caltech was featured on the cover of the Aug. 27, 2010 edition of Science. *The illustration by Georg Stadler of UT Austin shows the dynamic interaction of tectonic plates in the southwest Pacific Ocean computed from a flow model of Earth's interior (arrows show predicted velocity). The computational mesh, for which color represents viscosity (yellow, softer; blue, stiffer), is refined to resolve the forces in the deep mantle that are coupled directly into the edges of plates through narrow slabs. Red lines indicate low-viscosity zones corresponding to plate boundaries. See research brief on page 4. Cover image used with permission of* Science.



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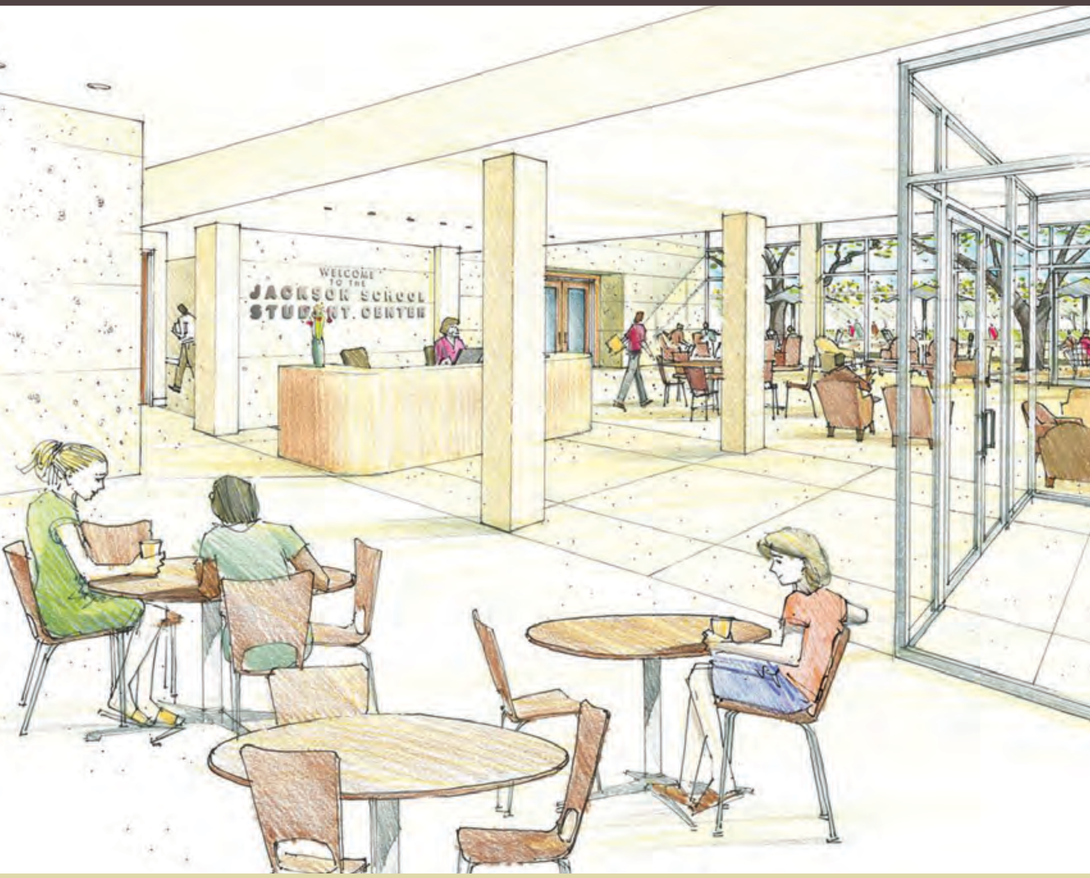


Architectural sketch of the new JSG Student Center. See page 24 for information on progress toward construction.

Dear Alumni and Friends,

It is my pleasure to share with you the 2010 Jackson School *Newsletter* covering the 2009-2010 academic year. This issue showcases the strength of our academic programs, the impact of our veteran faculty and research scientists, and the vitality of our outstanding recent hires.

With so many new faculty since 2008, we have devoted three issues to profiling them all. This edition wraps up the new hires by introducing you to two women who received national awards as top scientists in their fields and three other young faculty engaged in high impact research.

The disaster in Haiti was one of the most devastating geohazards in history. In the face of the tragedy, we are proud to see university researchers taking a lead role in assessing ongoing threats to the region, as detailed in our feature on Haiti. I encourage you especially to learn about the role played by Paul Mann of the Institute for Geophysics. He was one of the scientists who forecast the likelihood of a dangerous earthquake in the region.

At the forefront of geoscience affecting energy exploration, the Applied Geodynamics Lab continues to pursue pathbreaking research into salt tectonics, attracting widespread attention from industry. For his contributions to the field, Martin Jackson of the Bureau of Economic Geology received this year's Berg Award for Outstanding Research from the Association of American Petroleum Geologists (AAPG). AAPG also recognized Frank Brown of the Bureau with the Sydney Powers Memorial Award, its highest honor. Likewise the SEPM Society for Sedimentary Geology awarded Bill Galloway of the Institute its highest honor, the Twenhofel Medal. These and other awards are detailed in our briefs.

In addition to covering new achievements, these pages offer updates on some abiding strengths. The Gulf Coast Carbon Center continues to set the standard for academic research and testing of carbon sequestration. Once again GeoFORCE has expanded its innovative outreach programs. And our paleontology program remains one of the strongest in the country and an integral part of the overall geoscience curriculum.

With the accomplishments outlined in these pages, we remain firmly on the path to becoming the best geoscience program in the country. To be the best, we need both strong annual support and visionary gifts that will take us beyond the Jackson endowment. I encourage you to consider a contribution using the form included with this newsletter. And of course, update us on your activities so we can stay in touch and share your news with alumni and friends.

Sharon Mosher
Sharon Mosher
Dean

RESEARCH HIGHLIGHTS

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

An aerial view of restored wetlands showing two newly established delta lobes in Atchafalaya Bay, St. Mary Parish, Louisiana. Delta restoration in the Atchafalaya Delta helped Mohrig and Kim model how similar results could take place in the Mississippi River Delta. Source: NOAA.

Restoring the Delta

Diverting sediment-rich water from the Mississippi River below New Orleans could generate new land in the river's delta in the next century. The land would equal almost half the acreage otherwise expected to disappear during that period, a new study shows.

For decades, sea-level rise, land subsidence, and a decrease in river sediment have caused vast swaths of the Mississippi Delta to vanish into the sea. The anticipated build-up of new land in a portion of the delta, as simulated by a computer model, could compensate for a large fraction of the expected future loss, protect upriver areas from storm surges, and create fresh-water habitat, researchers say.

"What this model shows is that we can, to a large degree, match future land loss by making these diversions," says David Mohrig, an associate professor at the Jackson School.

He and Wonsuck Kim, an assistant professor at the Jackson School, led the study, reported in the Oct. 20, 2009 issue of *Eos*, the weekly newspaper of the American Geophysical Union.

The delta of the Mississippi River has been losing land to the sea at an average rate of about 44 square kilometers (17 square miles) per year since around 1940 The natural equilibrium between soil loss and sediment deposition has been altered by the levees the U.S. Army Corps of Engineers built below New Orleans to prevent the Mississippi from flooding.

History recorded in the river deposits shows that the main channel of the Mississippi moved roughly every 1,000 years to a new lowland area, Kim and Mohrig say. The engineering of the levees, they believe, has kept the river from entering lowland areas and depositing sedimentation.

The model looks at potential effects of an existing proposal to divert Mississippi River water through a pair of cuts made opposite each other in the levees 150 kilometers (93 miles) downstream from New Orleans. Nearly half of the river's flow would spill out through the cuts, taking sediment with it and depositing it to each side of the river channel.

Despite sea level rise, increased land sinking rates, and a drop in the river's sediment supply, the diversions would create an amount of new land equal to up to 45 percent of the area that would otherwise be lost to the sea in the coming century, the model predicts.

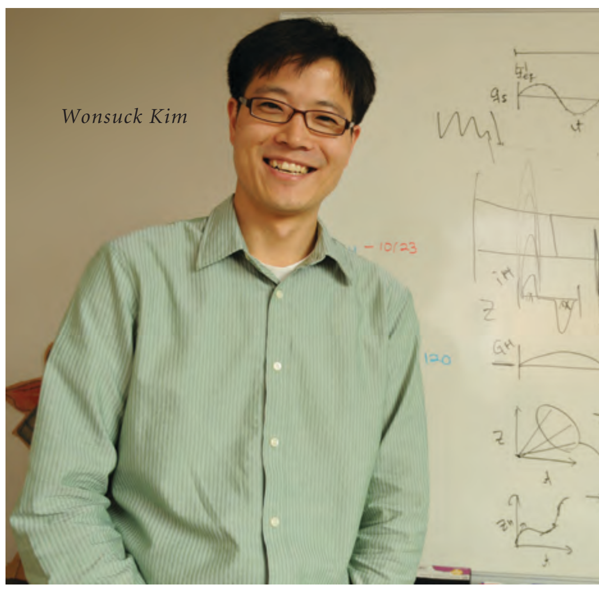
Other scientists have proposed creating these two diversions, but critics said dams in the upper sections of the Mississippi River had reduced the water's sediment content so much there was not enough raw material left to rebuild the delta.

"Until we put together this model, there was a lot of debate that wasn't substantiated by anything but by intuition," says Mohrig. "We needed to move from having very soft impressions of what could be done to making predictions that can actually be tested."

Using conservative inputs, the model predicts the two diversions would create between 701 square kilometers (about 271 square miles) and 1,217 square kilometers (470 square miles) of new land over a century, partially offsetting land loss.

Kim and Mohrig calculate the engineered new delta lobes would make up for 25 to 45 percent of the area expected to vanish throughout the delta between now and 2110.

"Diversions are really the only cost-effective way of building land," Mohrig says.



Wonsuck Kim

Modeling Plate Tectonics

Computational scientists and geophysicists at The University of Texas at Austin and the California Institute of Technology (Caltech) have developed a new supercomputer model that produces an unprecedented view of plate tectonics and the forces that drive it.

The paper, "The Dynamics of Plate Tectonics and Mantle Flow: From Local to Global Scales," which describes the whole-Earth model and its underlying algorithms, was published in the Aug. 27, 2010 issue of *Science* and featured on the cover.

To create the model, computational scientists at UT Austin's Institute for Computational Engineering and Sciences (ICES) extended the use of a computational technique known as Adaptive Mesh Refinement (AMR). The team included Omar Ghattas, the John A. and Katherine G. Jackson Chair in Computational Geosciences and Professor of Geological Sciences and Mechanical Engineering, UT Austin researchers Georg Stadler and Carsten Burstedde, and Caltech Professor Michael Gurnis.

"Many physical systems in science and engineering, including global mantle flow, exhibit behavior on a wide range of length scales," says Ghattas. "Modeling and simulation of such systems has always presented notorious challenges, particularly on the parallel supercomputers that are necessary to capture their multiscale behavior."

Mantle flow models, for example, must finely resolve plate boundaries while also representing the entire mantle. The only way to capture this wide range of scales is to use AMR methods.

"AMR adaptively creates finer resolution only where it's needed," explains Ghattas. "This leads to enormous reductions in the number of grid points, making possible simulations that were previously out of reach."

The group's work on parallel AMR algorithms has been selected as a finalist for the prestigious 2010 ACM/IEEE Gordon Bell Prize in Supercomputing.

The new AMR algorithms, combined with new scalable solvers, allowed the scientists to simulate global mantle flow and its manifestation as plate tectonics, including the motion of individual faults. A key to the model was the incorporation of data on a multitude of scales, from the largest scale of the whole Earth to the boundaries between plates, composed of many hundreds to thousands of individual faults, which constitute active fault zones.

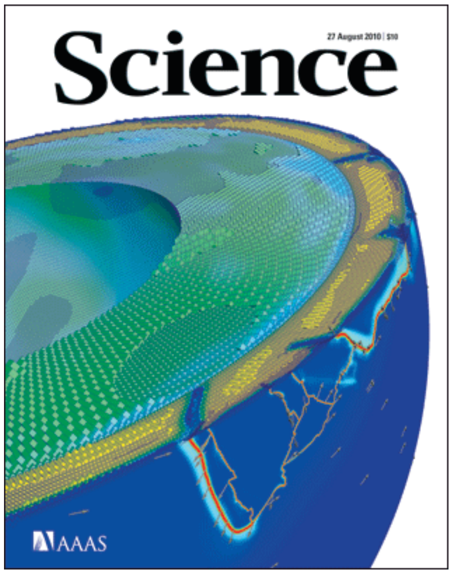
"The individual fault zones play a critical role in how the whole planet works," says Gurnis. "And if you can't simulate the fault zones, you can't simulate plate movement—and, in turn, you can't simulate the dynamics of the whole planet."

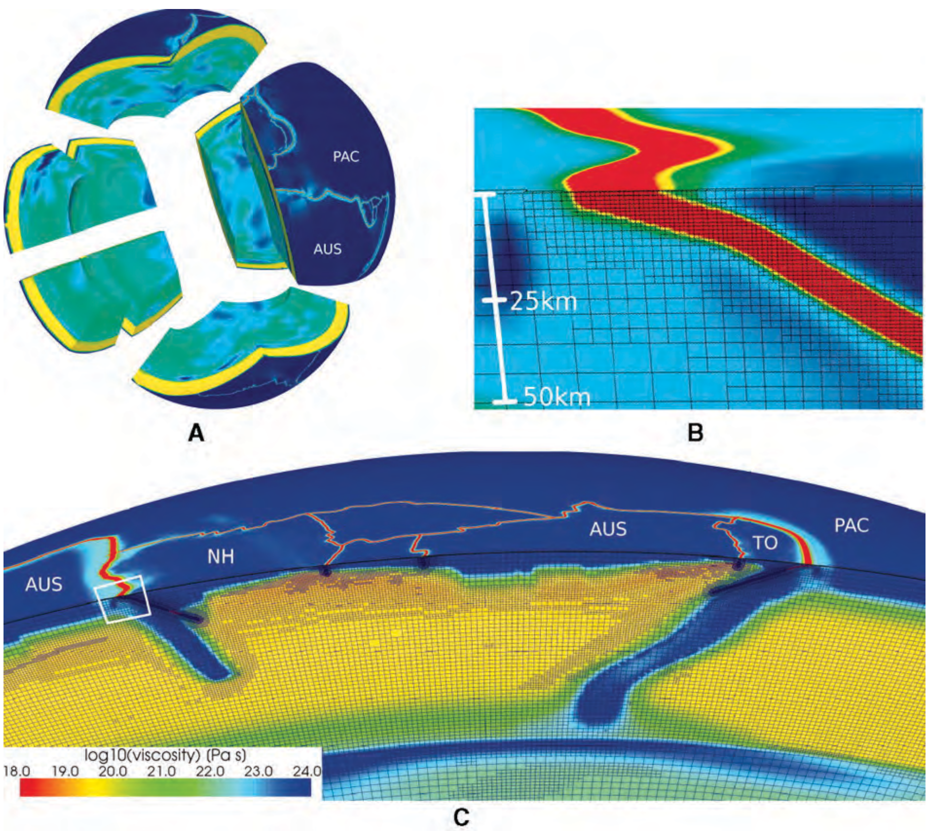
The resulting simulation of both large tectonic plates and smaller microplates, including their speed and direction, was remarkably close to observed plate movements.

The investigators also discovered that anomalous rapid motion of microplates emerged from the global simulations.

"In the western Pacific," Gurnis says, "we have some of the most rapid tectonic motions seen anywhere on Earth, in a process called 'trench rollback.' For the first time, we found that these small-scale tectonic motions emerged from the global models, opening a new frontier in geophysics."

Another surprising result relates to the energy released from plates in earthquake zones. "It had been thought that the majority of energy associated with plate





These three figures help show how Ghattas and colleagues used Adaptive Mesh Refinement to simulate the wide range of scales necessary for modeling plate tectonics. Figure A shows the splitting of Earth's mantle into 24 warped cubes. Figure B zooms into the hinge zone of the Australian plate (as indicated by the box in C) showing the adaptively refined mesh with a finest resolution of about 1 km. Cross section C shows the refinement that occurs both around plate boundaries and dynamically in response to the nonlinear viscosity, with plastic failure in the region from the New Hebrides to Tonga in the SW Pacific. Plates are labeled Australian, AUS; New Hebrides, NH; Tonga, TO; and Pacific, PAC. For more figures and information see the article in Science.

tectonics is released when plates bend, but it turns out that's much less important than previously thought," Gurnis says. "Instead, we found that much of the energy dissipation occurs in the earth's deep interior. We never saw this when we looked at smaller regions."

Demystifying Mars' Ice Cap

Scientists have reconstructed the formation of two curious features in the northern ice cap of Mars—a chasm larger than the Grand Canyon and a series of spiral troughs—solving a pair of mysteries dating back four decades while finding new evidence of climate change on Mars.

In a pair of papers published in the journal *Nature* on May 27, 2010, Jack Holt and Isaac Smith of The University of Texas at Austin's Institute for Geophysics and their colleagues describe how they used radar data collected by NASA's Mars Reconnaissance Orbiter to reveal the subsurface geology of the red planet's northern ice cap.

On Earth, large ice sheets are shaped mainly by ice flow. But on Mars, according to this latest research, other forces have shaped, and continue to shape, the polar ice caps.

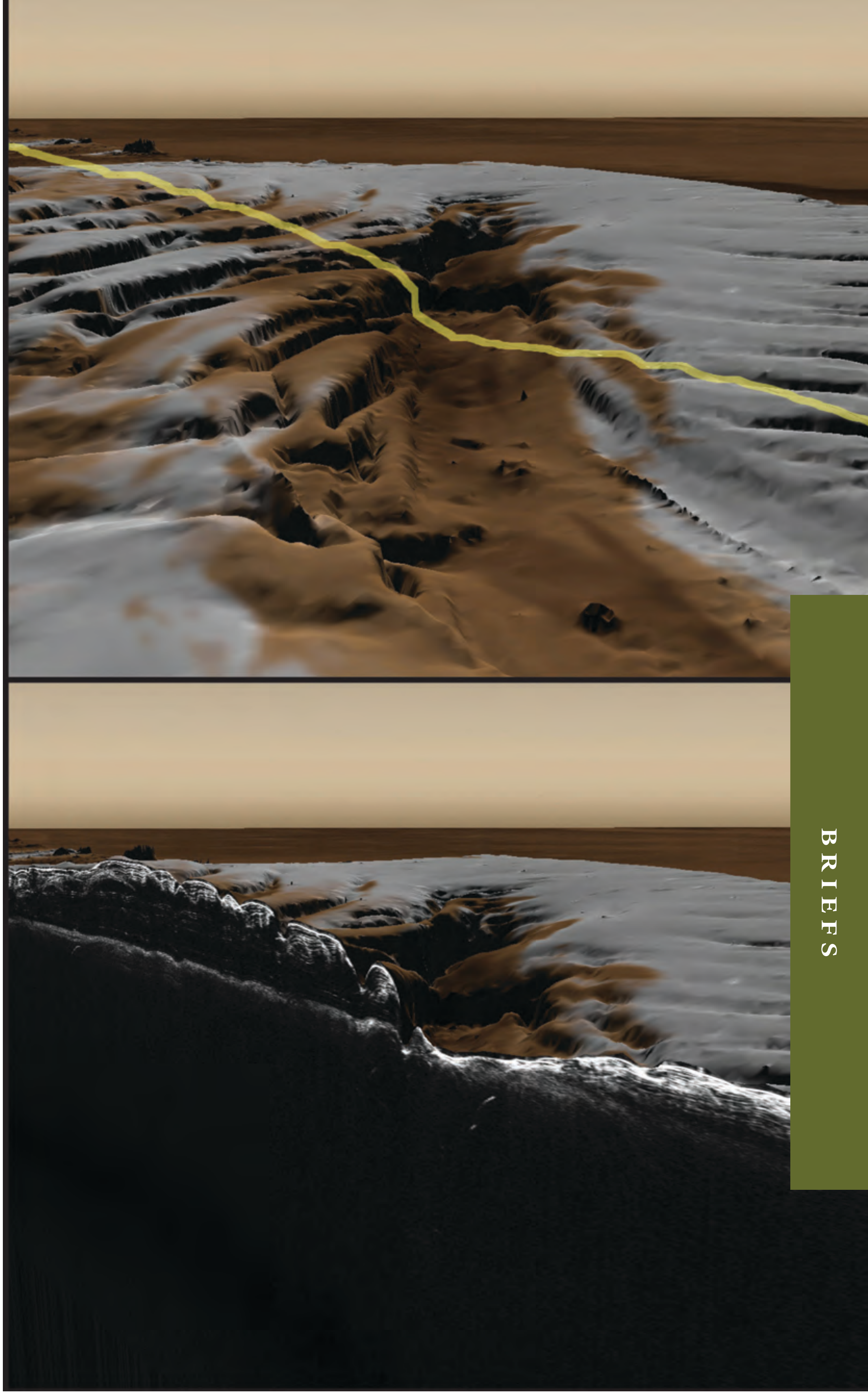
The northern ice cap is a stack of ice and dust layers up to two miles (three kilometers) deep covering an area slightly larger than Texas. Analyzing radar data on a computer, scientists can peel back the layers like an onion to reveal how the ice cap evolved over time.

One of the most distinctive features of the northern ice cap is Chasma Boreale, a canyon about as long as the Grand Canyon but deeper and wider. Other enigmatic features are troughs that spiral outward from the center of the ice cap like a gigantic pinwheel. Since they were discovered in 1972, scientists have proposed several hypotheses for how they formed.

It turns out both the spiral troughs and Chasma Boreale were created and shaped primarily by wind. But rather than being cut into existing ice very recently, the features formed over millions of years as the ice sheet itself grew. By influencing wind patterns, the topography of underlying, older ice controlled where and how the features grew.

Before this research, conventional wisdom held that the northern ice cap of Mars was made of many relatively flat layers like a layered cake. It was assumed some climate information would be recorded in the layers, limited to what could be gained from layer thickness and dust content. This research, however, reveals many complex features—including layers that change in thickness and orientation, or abruptly disappear in some places—making it a virtual gold mine of climate information.

"Nobody realized that there would be



Top: Perspective view of northern polar cap of Mars, looking up Chasma Boreale. Yellow line indicates ground track of SHARAD in orbit. Bottom: Cutaway view of same, showing subsurface layers as viewed by SHARAD. Credit: NASA/Caltech/JPL/E. DeJong/J. Craig/M. Stetson

Jack Holt

such complex structures in the layers," says Holt, lead author of the paper focusing on Chasma Boreale. "The layers record a history of ice accumulation, erosion and wind transport. From that, we can recover a history of climate that's much more detailed than anybody expected."

The spiral trough results vindicate an early explanation that had fallen out of favor in parts of the Mars scientific community. Alan Howard, a researcher at the University of Virginia, proposed just such a process in 1982 based solely on images of the surface from the Viking mission.

"He only had Viking images with relatively low resolution," says Isaac Smith, doctoral student and lead author on the spiral trough paper. Holt is second author on the trough paper. "Many people proposed other hypotheses suggesting he was wrong. But when you look at a hypothetical cross section from his paper, it looks almost exactly like what we see in the radar data."

These breakthroughs were made possible by a new instrument called Shallow Radar (SHARAD). Similar instruments have been used on aircraft in Antarctica and Greenland, but before its use at Mars, some scientists were skeptical it would be able to collect useful data from orbit. Holt is a Co-Investigator on SHARAD.

"These anomalous features have gone unexplained for 40 years because we have not been able to see what lies beneath the surface," said Roberto Seu, team leader for the SHARAD instrument. "It is gratifying to me that with this new instrument we can finally explain them."

Funding was provided by NASA and the Gayle White Fellowship at the Institute for Geophysics.

Tracking East Antarctic Ice Melt

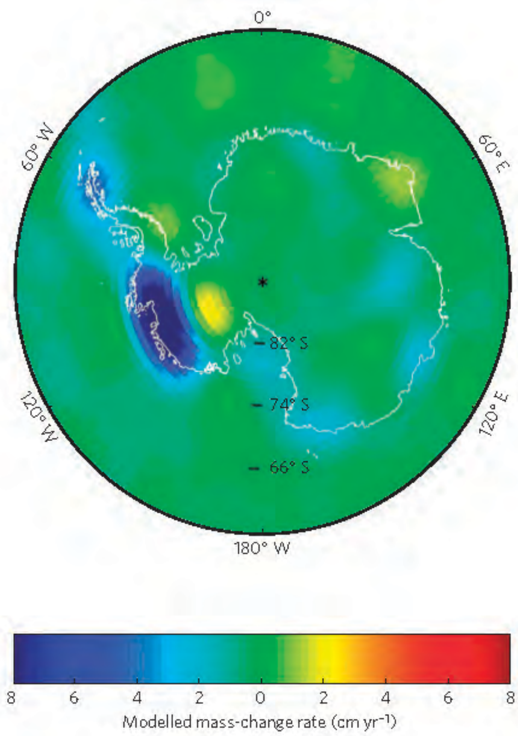
The East Antarctic ice sheet, Earth's largest repository of solid fresh water and previously considered stable, now appears to be losing ice at an estimated rate of 57 gigatonnes per year, according to scientists at The University of Texas at Austin.

Using gravity measurement data from the Gravity Recovery and Climate Experiment (GRACE) mission, researchers found that ice loss in East Antarctica may have begun as early as 2006. They also confirmed earlier estimates of ice loss in West Antarctica. The research was published in the Nov. 22, 2009 online edition of *Nature Geoscience*.

The GRACE mission consists of two satellites flying in formation making detailed measurements of Earth's gravity field. Earth's mass, and its gravity, varies from place to place. The mission is funded by NASA and the German Aerospace Center, and led by University of Texas Aerospace Engineering Professor Byron Tapley.

"One of the objectives of the GRACE mission is to look at mass flux globally, and one significant signal we see is ice loss in the polar regions," said Tapley, director of the university's Center for Space Research (CSR) and holder of the Clare Cockrell Williams Centennial Chair in Engineering. "Significantly, there appears to be a measurable signal that GRACE is picking up in the East Antarctic. Most previous research has assumed the East Antarctic ice sheet was stable. This is the first time we have been able to observe mass loss in this region from space, and this finding suggests that perhaps it is not stable after all."

Lead author Jianli Chen, a Senior Research Scientist at CSR and 1998 Ph.D. graduate from the Jackson School, worked with colleagues, including Jackson School Professor Clark Wilson, to use GRACE data to estimate Antarctica's ice mass between 2002 and 2009. In addition to new findings about the East Antarctic ice sheet, their recent work confirms previous results showing that West Antarctica loses 132 gigatonnes of ice per year.



This antarctic rate map from forward modelling shows the predicted loss of ice in Antarctica based on the GRACE results from November 2009. While melting in the West Antarctic Ice Sheet has long been observed, instability in portions of East Antarctica is a new phenomenon.

"East Antarctica is the biggest chunk of ice on Earth," said Chen. "As a whole, Antarctica holds around 90 percent of the Earth's solid fresh water, and the majority is in East Antarctica. East Antarctica is so cold that it was generally believed that its mass was in balance, with not much net change. Data from GRACE shows that some coastal regions are losing ice, in particular the Wilkes Land and Victoria Land regions."

GRACE researchers had previously documented ice loss in the West Antarctic Ice Sheet but had considered East Antarctica "to be inviolate," Chen said. "But if it is losing mass, as our data indicates, it may be an indication the state of East Antarctica has changed. Since it's the biggest ice sheet on Earth, ice loss there can have a large impact on global sea level rise in the future."

Edited from a news release by the Consortium for Ocean Leadership.

Confirming Impact

Responding to challenges to the hypothesis an asteroid impact caused a mass extinction on Earth 65 million years ago, a panel of 41 scientists, including Gail Christeson and Sean Gullick of the Jackson School's Institute for Geophysics, re-analyzed data and provided new evidence, concluding an impact in Mexico was indeed the cause of the mass extinction.

Thirty years ago, Luis Alvarez, Jan Smit, and their coworkers suggested a large meteorite slammed into Earth 65 million years ago and caused one of the most severe mass extinctions in Earth's history, ending the age of the dinosaurs. In 1991, a more than 200-kilometer-wide impact crater was discovered in Yucatan, Mexico, that coincided with the extinctions. Since then, the impact hypothesis has gained overwhelming acceptance within the scientific community.

Still in recent years, a few scientists have challenged this hypothesis. To address their claims, a panel of 41 experts from Europe, the U.S., Mexico, Canada, and Japan provided new data from the analysis of ocean drilling and continental sites and re-analyzed the relevant literature in the field, including the most recent research. In a review paper in the March 5, 2010 edition of *Science*, the multinational, multidisciplinary team found that alternative hypotheses are inadequate to explain the abrupt mass extinction and that the impact hypothesis has grown stronger than ever.

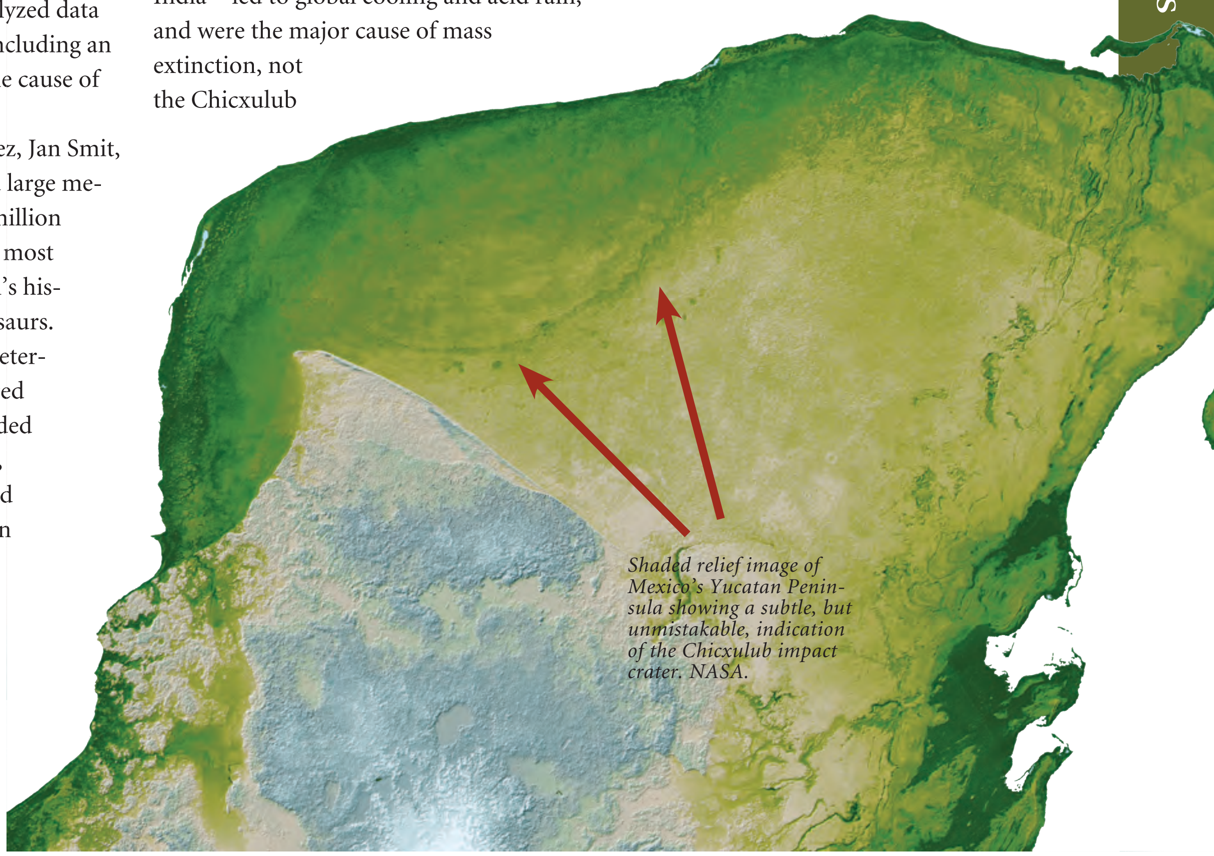
The fossil record clearly shows a mass extinction event across the planet at about 65.5 million years ago, the dramatic change geologists use to define the end of the Cretaceous period and the start of the Paleogene (formerly called the Tertiary), referred to as the K-Pg boundary.

Critics of the Chicxulub ("chik-shoo-loob") impact theory claim the impact happened 300,000 years before the K-Pg boundary and therefore came too early to have been the major cause of extinctions. They point to deposits at sites around the Gulf of Mexico with a layer of tiny glass-like blobs of melted impact material that, according to their interpretation, was deposited at about 300,000 years before the K-Pg boundary mass extinction. As an alternative, they suggest the Deccan Traps—unusually active volcanoes in what is now India—led to global cooling and acid rain, and were the major cause of mass extinction, not the Chicxulub impact in Mexico.

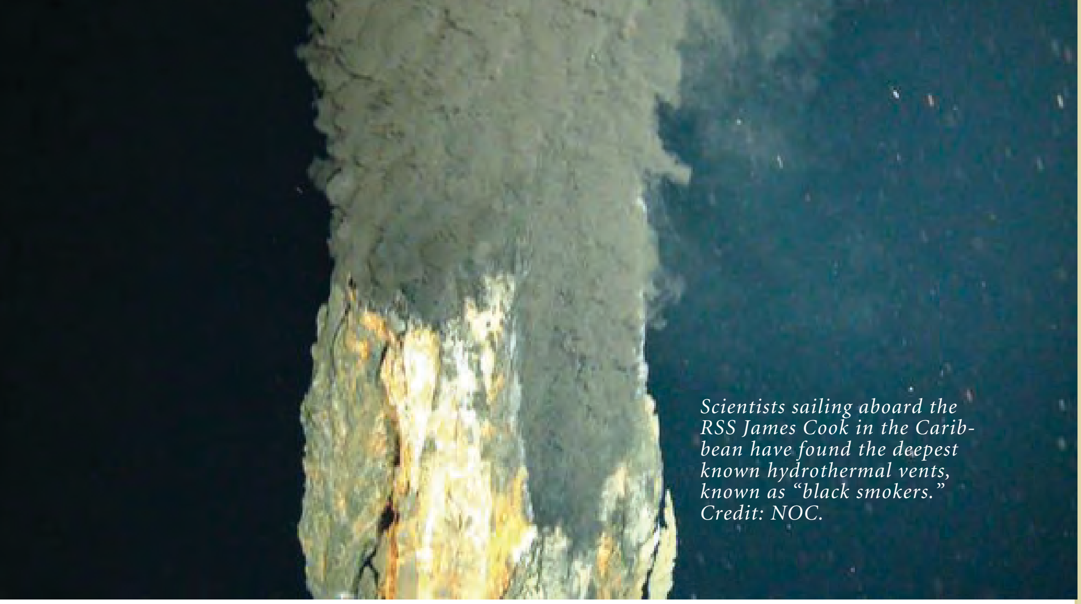
However, the study's authors find that what appears to be a series of layers neatly laid down over 300,000 years near the impact site were actually violently churned and then dumped in a thick pile in a very short time. Models suggest the impact at Chicxulub was a million times more energetic than the largest nuclear bomb ever tested. An impact of this size would eject material at high velocity around the world, cause earthquakes of magnitude >10, continental shelf collapse, landslides, gravity flows, mass wasting, and tsunamis and produce a relatively thick and complex sequence of deposits close to Chicxulub.

"If we are to unravel the sequence of events across the K-Pg boundary, perhaps the last place in the world we should look is close to the Chicxulub impact site, where the sedimentary deposits will be most disturbed," write the authors.

In addition, the authors note, as you go farther from the impact site, these layers become thinner and the amount of ejected material decreases until it becomes one layer that can be found globally exactly at the K-Pg boundary coincident with the mass extinction. Moreover, the ejecta within the



Shaded relief image of Mexico's Yucatan Peninsula showing a subtle, but unmistakable, indication of the Chicxulub impact crater. NASA.



Scientists sailing aboard the RSS James Cook in the Caribbean have found the deepest known hydrothermal vents, known as "black smokers." Credit: NOC.

global K-Pg layer is compositionally linked to the specific sediments and crystalline rocks at Chicxulub.

Several mechanisms have been proposed to explain why the impact was so deadly. In February 2008, Gulick and Christeson of the Institute for Geophysics published with colleagues a study in *Nature Geoscience* finding the asteroid landed in deeper water than previously assumed and therefore released more water vapor and sulfate aerosols into the atmosphere. Gulick, a co-author of the new review paper in *Science*, said this could have made the impact deadlier by altering climate and by generating acid rain, a finding that strengthens the case for the impact hypothesis.

World's Deepest Vents

Nick Hayman, structural geologist at the Jackson School's Institute for Geophysics, was part of the onboard science team of the Caribbean expedition that in April 2010 discovered the world's deepest known hydrothermal vents, also known as black smokers. The vents are located in the Cayman Trough, the world's deepest undersea volcanic rift, running across the seafloor between the Cayman islands and Jamaica.

Hayman is studying unusually large faults of the Cayman Trough to understand the fundamental behavior of faults worldwide.

Deep-sea vents are undersea springs where superheated water erupts from the ocean floor, nourishing lush colonies of deep-sea creatures. Studying the life-forms that thrive in such unlikely havens is providing insights into patterns of marine life around the world, the possibility of life on other planets, and even the origins of life on Earth.

Using a deep-diving vehicle remotely controlled from the Royal Research Ship James Cook, scientists found slender spires made of copper and iron ores on the seafloor, erupting water hot enough to melt lead, nearly half a mile deeper than anyone has seen before. The vents, which have not been officially named yet, are in water nearly 5 kilometers (3.1 miles) deep. The site was the setting for James Cameron's film The Abyss.

The moment of vent discovery was captured in the ship's blog:

"After five hours surveying the seafloor … HyBIS [a remotely controlled submarine] came across rust-coloured blocks of sulphide on the seafloor, which told us that the vents were nearby. After a little further exploration, a tremendous roar went up in the main lab as a beautiful cluster of black smokers came into camera view. It was an amazing feeling to know that in a world with more than six billion people, we were seeing part of our planet that no-one had ever seen before."

Lead researchers from the expedition, all from the National Oceanography Centre in Southampton, UK, will now compare the marine life in the abyss of the Cayman Trough with that known from other deep-sea vents. The team will also study the chemistry of the hot water gushing from the vents, and the geology of the undersea volcanoes where these vents are found, to understand the fundamental geological and geochemical processes that shape our world.

Paleontology Research

For more see our feature article on the paleontology program in on page 62.

Rethinking Age of Dinosaurs

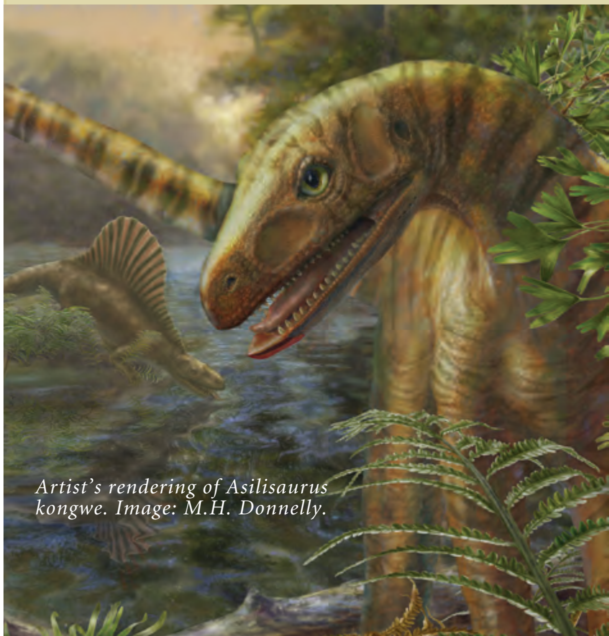
Paleontologists announced the discovery of a dinosaur-like animal—one that shared many characteristics with dinosaurs but fell just outside of the dinosaur family tree—living 10 million years earlier than the oldest known dinosaurs. The researchers conclude that dinosaurs and other close relatives such as pterosaurs might have also lived much earlier than previously thought.

The description of the new species *Asilisaurus kongwe* (a-SEE-lee-SOAR-us KONG-way) appears in the March 4, 2010 issue of the journal *Nature* in a paper lead-authored by Sterling Nesbitt, a postdoctoral researcher at the Jackson School. Nesbitt conducted the research with his colleagues while a graduate student at Columbia University's Lamont-Doherty Earth Observatory and the American Museum of Natural History.

The research also suggests that at least three times in the evolution of dinosaurs and their closest relatives, meat-eating animals evolved into animals with diets that included plants. These shifts all occurred in the relatively short geologic period of less than 10 million years.

Although difficult to prove, it's possible this shift conferred an evolutionary advantage. An ecosystem can support far more plant eaters than meat eaters, so being able to eat plants might have opened up a broader range of habitats.

"This goes to show that there are whole



Artist's rendering of Asilisaurus kongwe. Image: M.H. Donnelly.

Artist's rendering of Anchiornis huxleyi *by Michael DiGiorgio.*

groups of animals out there that we've never even found evidence of that were very abundant during the Triassic," said Nesbitt. "It's exciting because it means there is still so much chance for discovery."

Painting Dinosaurs' True Colors

Two groundbreaking papers—one in the Jan. 27, 2010 edition of *Nature* and another in the Feb. 5 edition of *Science*—have for the first time revealed the true colors of dinosaur feathers. Now it's possible to illustrate what some dinosaurs looked like without having to guess.

The first team identified colors in isolated spots on several dinosaurs. The second team, which included Jackson School paleontologist Julia Clarke, went further.

They mapped out the colors and color patterns of an entire dinosaur from head to tail, picking up color patterns not just across whole regions of feathers but also within individual feathers. The dinosaur in question is a 155-million-year-old *Anchiornis huxleyi* discovered in China. It was the size of a chicken and, as the new study reveals, had black and white stripes and splotches with a rusty red crown.

Clarke combined this information with earlier studies that found evidence for dark and light bands on dinosaur feathers (based on a different technique that couldn't identify specific colors) to learn more about the early evolution of feathers in dinosaurs. Scientists have debated why elongate feathers, a type used for flight in modern birds, appeared in dinosaurs long before they were actually capable of flight. Using cladistics, a technique for establishing evolutionary relationships between species and tracking changes in physical characteristics over time, she found what she was looking for.

"When elongate feathers first appear [in the fossil record], they are already distinctively spotted and striped," Clarke told National Geographic News. "We now have patterns within individual feathers in dinosaurs long before we get some kind of aerial locomotion."

This, she says, adds more weight to the hypothesis that early on, feathers were used not for flight but for display. In other words, they might have helped attract mates, provide camouflage, confuse predators, frighten prey, or establish territory.

Carnivore Changes Family Tree

Paleontologists, aided by amateur volunteers, have unearthed a previously unknown meat-eating dinosaur from a fossil bone bed in northern New Mexico, settling a debate about early dinosaur evolution, revealing a period of explosive diversification, and hinting at how dinosaurs spread across the supercontinent Pangaea.

The description of the new species, named *Tawa* after the Hopi word for the Puebloan sun god, appears in the Dec. 10, 2010 issue of *Science* in a paper lead-authored by Sterling Nesbitt of the Jackson School.

The fossil bones of several individuals were recovered, but the type specimen is a nearly complete skeleton of a juvenile that stood about 28 inches (70 cm) tall at the hips and was about 6 feet (2 meters) long from snout to tail. Its body was about the size of a large dog, but with a much longer tail. It lived about 214 million years ago, plus or minus a million. The specimens are remarkable because they show little sign of being flattened during fossilization.

Tawa is part of a group of dinosaurs known as theropods, which includes T. Rex and Velociraptor. Theropods for the most part ate meat, walked on two legs, and had feathers. Though most went extinct by 65 million years ago, some lineages survived to spawn modern birds.

Tawa's discovery helps place another dinosaur, *Herrerasaurus*, firmly within the theropod lineage, resolving a longstanding controversy. The lineage points up an interesting fact about dinosaur evolution: once they appeared, they very rapidly diversified into the three main dinosaur lineages that persisted for more than 170 million years.

"*Tawa* pulls *Herrerasaurus* into the theropod lineage, so that means all three lineages are present in South America pretty much as soon as dinosaurs evolved," said Nesbitt. "Without *Tawa*, you can guess at that, but *Tawa* helps shore up that argument."

The National Science Foundation and the National Geographic Society sponsored the research, which was featured in the NSF-funded IMAX 3-D movie "Dinosaurs Alive!"

Julia Clarke

SPEAKERS & LECTURES

Thin Blue Line

Sally Ride was just a couple of months from completing her Ph.D. in astrophysics at Stanford University when she saw an ad in the school paper seeking candidates for the first new class of astronauts since the Apollo program. She ripped it out and applied that afternoon. Ride went on to become the first American woman in space.

Looking down on our planet from hundreds of miles up gave her a kind of perspective that few ever get, she explained to an enthusiastic crowd who had come to LBJ auditorium at The University of Texas at Austin to hear her Hot Science Cool Talk on a Friday night in October. She presented vivid memories (and photographs) of coral reefs off the coast of Australia, glaciers in the Himalayas and Rockies, deforestation of the Amazon rainforest, and smog over her hometown of Los Angeles. But the most striking sight, the one that reshaped her whole view of our planet, was what she saw when she first looked at the horizon through the spacecraft window.

"It looks like someone took a royal blue crayon and traced the outline of the Earth," she said. "That thin blue line is Earth's atmosphere. That's all that separates everything on our planet from the blackness, the vastness of space."

"When you're standing on the Earth," she continued, "it looks like the air goes on forever. When you see it from this perspective, it's obvious how thin our atmosphere really is and it makes you appreciate how fragile [it] is."

When Ride was growing up, the country's grand challenge was reaching the moon. Today, she believes the grand challenge is climate change. Ride clicked through a series of slides showing Earth from space. Astronauts taking one particular picture of the Amazon thought it was a very cloudy day. It turned out the entire region was cloaked in smoke from fires set to clear rainforest for farming and ranching. Deforestation releases greenhouse gases into the atmosphere and alters local rainfall patterns.

Photos of the Middle East highlight struggles over a limited water supply that are likely to become worse as global temperatures rise and rainfall patterns shift. Photos of the ocean showing cloudy patches of phytoplankton highlight the role these microscopic organisms play in storing carbon. The retreat of most glaciers around the world is obvious from orbit too.

"The problem is there's no magic bullet," said Ride. "This is a very, very hard problem and it will take a lot of different approaches and different solutions."

Ride attacks the climate change problem by supporting science education. Through her company Sally Ride Science, she is helping cultivate a new generation of scientists who will tackle the problem. And even for those children who won't grow up to be scientists, said Ride, it's critical that everyone be scientifically literate.


Sally Ride

Even though she loved science and math from elementary school right up through high school, she almost didn't become a scientist. She thought she wasn't smart enough to go to college and study science. But two high school science teachers had a big influence on her.

"They spent a lot of time with me and helped build my confidence in myself," she said.

Sally Ride

After Copenhagen

In April 2010, climate scientists, educators, policy scholars, and political leaders from the U.S. and Canada came together for a conference titled After Copenhagen: Collaborative Responses to Climate Change. The goal was "to bridge science, public understanding and political action on climate change adaptation and mitigation."

The conference was sponsored by the LBJ School of Public Affairs, The Institute for Innovation, Creativity and Capital (IC^2), and two units of the Jackson School of Geosciences: the Environmental Science Institute and the Center for International Energy and Environmental Policy (CIEEP). Two sessions were moderated by Charles Groat, director of CIEEP, and Suzanne Pierce, research assistant professor in the Jackson School. Several experts from the Jackson School gave presentations.

Ginny Catania said everyone wants to know what's going to happen to Earth's polar ice sheets. But the reality is the cryosphere is extremely complex and there isn't enough data to make accurate predictions.

"We have more data on the thickness of the polar ice caps on Mars than we do on Earth," said Catania, research associate and assistant professor in the Jackson School.

"We need more data," she said. "Simply taking an observation and then coming back and doing it again 10 years later isn't sufficient."

Ramón Treviño addressed the question of whether carbon capture and storage (CCS) could realistically mitigate greenhouse gas emissions. Treviño, research associate at the Jackson School's Bureau of Economic Geology, pointed out that oil and gas companies began pumping CO_2 underground in west Texas 40 years ago as a way to get more petroleum out of the ground. Its proven track record and obvious economic benefits make enhanced oil recovery (EOR) a good candidate for the first commercially viable CCS projects. He noted there appears to be ample storage capacity in the subsurface to store many decades worth of U.S. CO_2 emissions.

Still, environmentalists and others have raised concerns about possible leaks to the surface harming humans and wildlife, negative impacts on drinking water, and the induction of earthquakes. Treviño said none of these risks is a deal breaker.

"The risks of geological sequestration are modest and well known," he said. "We know how to address and avoid them. The other nice thing is that it can be done through existing regulations because they were already developed for EOR."

Michael Webber addressed the question of whether or not technology can fix the climate change problem. His answer was simple and direct:

"Yes," said Webber, assistant professor of mechanical engineering and associate director of CIEEP. "We have the technology in hand. We can make a car that gets twice as much fuel per gallon. We can choose nuclear, natural gas, solar, wind, biomass and geothermal energy. We can dial back our coal use by 80 percent."

He said this shift in energy would reduce carbon emissions and foreign sources of energy and it can happen in less than 20 years. In essence, we don't have to wait for some dream technology to save us. The challenge, he acknowledged, is dealing with political, economic and cultural resistance to change.

"It's not a very popular idea," he said. "People would rather say it's not my responsibility or we'll wait until the perfect technology comes along and then we'll change. We need to man up and deal with it instead of continuing to push it downstream."

Jay Banner wondered why so much of the public still sees climate change as controversial, despite strong agreement within the scientific community. "I think it boils down to the state of science education in the U.S.," concluded Banner, professor and director of the Environmental Science Institute. To improve science education, he and colleagues have proposed a new bachelor's of science degree in environmental science at UT Austin. As the proposal winds its way through the administration, Banner hopes it will be in place by this fall.

Unlike other environmental science degrees, it will be broadly interdisciplinary, including courses in math, chemistry, physics, geology, biology, geography, economics, policy, climate, and oceans. All of the required courses are already in place including the Sustaining a Planet signature course, a field seminar in environmental science and sustainability, a research methods course, and a capstone professional development sequence.

A Few Other Outside Speakers, 2009-10

Simon Shaw, ConocoPhillips, "Recent seismic technology research topics at ConocoPhillips"

Thomas Duffy, Princeton University, "Journey to the core-mantle boundary"

Rosemary Knight, Stanford University, "Geophysical methods for groundwater evaluation and management"

Charles Harvey, MIT, Oliver Distinguished Lecturer, "Origins and solutions of the arsenic crisis in south Asia"

David Rubie, Universitat Bayreuth (Germany), "Accretion and early differentiation of the Earth"

2010 EDGER Forum Technical Symposium, various speakers, topics: 1) unconventional resources & shale production, 2) time lapse seismic & reservoir characterization, and 3) numerical simulation & methods

John L. Flynn, Dean, Richard Gilder Graduate School (American Museum of Natural History), Langston Lectureship in Vertebrate Paleontology, "Cenozoic Andean faunas, paleoenvironments and tectonic history: Evidence from fossil mammals"

This Isn't The Finish Line

From the valedictorian speech at the Fall 2010 commencement address by Adam Allan:

You'll leave here today ... with a degree from one of the finest geological institutions in the country. You've been taught by a faculty of pioneers in their field of research. They've held up their end of the bargain, they've exposed you to what you need to know to be a successful geoscientist; they've given you the tools you need to do whatever you want in geoscience. Suffice it to say, thanks to their tireless effort, you know stuff. You know whatever it is you need to know to get your respective degree from the University of Texas, which is no mean feat, you should all be incredibly proud of yourselves. But this isn't the finish line, it's not even half way there, this is just a check point on the way, there are many more challenges to be faced, and much more to be learned. What defines the rest of your life is how you choose to face those challenges – be good enough, do the bare minimum, or exceed expectations. You've been given the tools, now hold up your end of the bargain, strive for brilliance, avoid complacency, and go out and do something revolutionary, change something, be something more than you are now.

The Jackson School's new summer geology camps, a joint project with UTEACH, offer a new way to inspire students in Austin, complementing GeoFORCE's work with older students in Southwest Texas and Houston.

OUTREACH

JSG, UTeach Host Geology Summer Camp

This past summer, the Jackson School teamed up with UTeach, a science teacher training program, to host several geology summer camps for children from Austin schools. The camps were designed to inspire participants to choose science as an academic or professional pursuit.

Jackson School scientists Afu Lin and Matthew Colbert talked to the students about their work, guided them through hands-on activities, and took them on lab tours. Graduate student Erin Eastwood and undergraduate student Caleb Jacobs assisted with tours and exhibits at the Texas Memorial Museum. Jessica Gordon, a graduate student in education, led a field trip to McKinney Falls State Park.

About 100 sixth, seventh, and eighth graders were chosen from three underrepresented groups and Kealing Middle School. In addition, club sponsors from the UTeach Outreach Science, Technology, Mathematics and Engineering (STEM) clubs selected two students to participate in the summer camps.

The students learned a variety of geology topics covering minerals, caves, geologic time, fossils, plate tectonics, and earthquakes.

"I had so much fun studying the Earth layers and I had fun learning about geologists," wrote Maykel N. "Someday I wish to be a geologist. Thank you."

Middle School Teacher Joins Record-Breaking Expedition

Julie Ann Pollard has spent years teaching science to 7th and 8th graders in Texas, but for two months in late 2009, she had a chance to really live it, as the onboard education officer for Expedition 317 of the *JOIDES Resolution*, the scientific ocean drilling and research vessel supported by the Integrated Ocean Drilling Program (IODP). Expedition 317 set a number of records including deepest hole drilled in a single expedition and second deepest hole in the history of scientific ocean drilling. (Craig Fulthorpe of the Institute for Geophysics was co-chief scientist. See our feature article on the expedition in this issue.)

As the onboard education officer, Pollard had the opportunity to learn shipboard science and translate her learning experiences for students, families, and the general public through a blog, live video conferencing from the ship, and classroom activities. Students followed Pollard from her first work shift at sea to the excitement of the record-breaking day: "When we hit 1800 meters below sea floor," blogged Pollard, "this hole became the deepest sedimentary rock hole cored on a DSDP, ODP, or IODP expedition. It's a pretty amazing feat that our drillers have pulled off, drilling that far in sedimentary rock in relatively shallow (for the JR) water."

Pollard teaches 7th and 8th grade science at Watauga Middle School in Watauga, Texas. You can find an archive of her blog at http://joidesresolution.org/blog/9.

Fomel Caps Off Bureau Centennial Lectures

On Dec. 8, 2009, Sergey Fomel gave the final presentation of the Bureau of Economic Geology's Centennial Distinguished Lecture program to 40 people at the Calgary Society of Exploration Geophysicists. Fomel, along with the Bureau's other distinguished lecturers, gave 50 presentations in 10 states around the U.S., Canada, Africa, and Mexico. More than 3,700 people attended these events and all the lectures were well received. Other presenters included Shirley Dutton, Bob Hardage, Sue Hovorka, Mike Hudec, Martin Jackson, Charlie Kerans, Steve Laubach, Bob Loucks, Jerry Lucia, Steve Ruppel, Bridget Scanlon, and Lesli Wood.

TXESS Revolution Brings Earth Science to Thousands

In its third year since receiving funding from the National Science Foundation, TXESS Revolution (TeXas Earth and Space Science Revolution) continues its outstanding work preparing Texas educators to teach the new Earth and Space Science capstone course. TXESS Revolution is providing professional development to 166 Texas teachers. TXESS Revolution teachers are reaching a geographically, economically, and ethnically diverse group of about 17,000 students and have conducted project-related outreach to more than 1,910 other teachers. Evaluation results show teachers have a very favorable attitude towards the professional development program, and are making significant gains in their knowledge, enthusiasm, and confidence with earth sciences.

Funded by NSF for five years, the project has laid a foundation to obtain support that will extend its mission. New opportunities include collaborating on Department of Energy-sponsored outreach on carbon sequestration, working with the Texas Water Development Board on a project in water exploration, and contributing to NASA-sponsored curriculum modules on climate and Earth system science.

Middle school teacher Julie Pollard on board record-breaking IODP Expedition 317 on the Joides Resolution.

Southwest Texas Students Enjoy Internships at UT Austin

Ten Southwest Texas Junior College students had hands-on scientific research experience this summer as part of an initiative at The University of Texas at Austin. This is the second group of SWTJC students to participate in the Freshman Research Initiative (FRI) at UT Austin, a joint offering from the university's Jackson School of Geosciences and College of Natural Sciences.

"This year we were able to double the amount of students selected to participate in the internship. These students will participate in lab intensive research and will spend 40 hours a week in various labs working with UT professors and other students on a variety of projects," said Kristi Gerdes of SWTJC. "This is a great opportunity for SWTJC students to learn what research at a major university is all about."

Students were assigned to a variety of research projects across the sciences. They live on the UT Austin campus for 10 weeks. Participants from SWTJC received scholarships to cover all costs. In addition, they each received a $2,500 stipend at the conclusion of the internship.

Tony Braden, a 1996 graduate of Sabinal High School who is attending San Angelo State University this fall, said he had decided to double major in physics and mathematics after his second year in the internship program.

Hector Valdez, who is working on an associate of applied science degree in computer information systems and plans to obtain a bachelor's degree in computer science at UT Austin, said the internship helped him get experience in his field. "I'll also have an idea of what to expect when I come back next year to pursue my bachelor's degree," said Valdez.

"Our program wants to encourage area students to pursue math and science related degrees and we will help them in any way we can," Gerdes said.

Summer geology camp students in Afu Lin's lab at the Jackson School.

IN THE NEWS 2009-10

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.

Don't Forget Basic Research

***New Technology Magazine,* Oct. 1, 2010**

More funding for basic research is needed to encourage development of new technologies to unlock the world's unconventional resources, petroleum geologists heard at an AAPG conference in Calgary. "Research drives the development of new technologies and technology applications inspire new research," said Scott Tinker, director of the JSG's Bureau of Economic Geology. The oil industry invests heavily in technology yet that far exceeds its investment in basic research, said Tinker. While he wasn't trying to trivialize an annual $1 billion of research in the exploration and production sector, the ratio of technology to basic research is large. "Yet we need basic research and technology to discover and extract the significant oil and gas resources that remain—and they do remain; our challenge is to get them," he said.

Giant Fossil Penguin Didn't Wear Tux

***New York Times, BBC, NPR et. al,* Sept. 30-Oct. 4, 2010**

"Penguins didn't always wear tuxedos," reported John Noble Wilford on the front page of the Science section of the Sept. 30 *New York Times*. "At least a large penguin that lived 36 million years ago looked nothing like Fred Astaire stepping out in high society." The Times joined hundreds of news outlets worldwide reporting publication of a discovery—led by JSG paleontologist Julia Clarke—of a giant fossilized penguin in Peru. The fossils of the first extinct penguin to be found with preserved evidence of feathers showed it had yet to adopt the tuxedo look of living penguins. Its feathers were predominantly reddish brown and shades of gray. The findings corroborated previous skeletal evidence that penguins had by then evolved the flippers and body shape for powerful swimming—birds in "aquatic flight," as scientists characterize their marine behavior. "It's a pretty major transition to go from aerial flight to aquatic flight, to flying in a medium that's around 800 times denser than air," Clarke said, adding: "I think there will be more to the story of this penguin's feathering." Clarke published the discovery in the Sept. 30 issue of *Science*.

Will Gulf Regain Lost Jobs?

***Christian Science Monitor,* Sept. 20, 2010**

A federal moratorium on deepwater drilling imposed after the Gulf oil spill is expiring this fall, but economists warn oil companies may not be prepared to restore the thousands of jobs lost. What is becoming a matter of debate is how much the six-month halt in operations will affect the region's long-term employment as oil companies may consider moving to foreign waters with less onerous regulations. According to Michelle Foss, chief energy economist at the Bureau of Economic Geology at the University of Houston, oil companies are facing "a lot of open-ended risk," especially at the end of the year when drilling leases and contracts are up for renewal.

Julia Clarke working on fossil of Inkayacu paracasensis. *For an artist's recreation of the penguin, see feature article on the paleontology program in this issue.*

Scott Tinker

Simulations Map Motions of Earth's Mantle

***Supercomputing,* Sept. 3, 2010**

On parts of the sea floor, the motion of tectonic plates can be extremely fast. Nowhere is this better displayed than in the southwest Pacific where one literally sees plates falling into the mantle in a process called trench rollback. There, on a little microplate in the kingdom of Tonga, near Australia, two islands converge at a rate of 25 centimeters per year, nearly 10 times faster than the speed of tectonic plates elsewhere. "This phenomenon has eluded numerical simulation for years," said Michael Gurnis, Professor of Geophysics at the California Institute of Technology. Three years ago, researchers from Caltech and The University of Texas at Austin came together to create a computational tool that could model the Earth and answer pressing questions in geophysics: What controls the speed of plates? How do microplates interact? How much energy do the plates generate and how does it dissipate? Using a new geodynamics software package they developed, the researchers have modeled plate motion with greater accuracy than ever before. A core component of the software performs

BRIEFS

a process called adaptive mesh refinement (AMR) that focuses the simulation on the parts of the model that matter. "By using adaptive mesh refinement to reduce the number of unknowns by three orders of magnitude, we can resolve both fine-scale and large-scale features simultaneously," said Omar Ghattas, a professor in the JSG and in the Institute for Computational Engineering and Sciences at The University of Texas at Austin.

Opinion: Food Waste Leads to Energy Waste

***New Scientist,* Aug. 14, 2010**

"The scandal of food waste is even worse when you consider how much energy is being thrown away," writes Michael Webber, associate director of UT Austin's Center for International Energy and Environmental Policy. He points out the energy footprint of food is enormous. Between one-quarter and one-third of the food produced in the US gets wasted, for a variety of reasons. "Whatever the reason, food waste has a large cumulative impact. A recent analysis at The University of Texas at Austin found that close to 2.2 million terajoules embedded in food waste was discarded in the US in 2007—the energy equivalent of about 350 million barrels of oil. This means that at least 2 percent of the total US energy budget is literally thrown in the trash."

Omar Ghattas

Michael Webber

Geology Reveals Ancient Origins of Offshore Oil

***New York Times,* Aug. 2, 2010**

Many people grew up believing oil came from the bodies of decaying dinosaurs and land organisms, but today, a principal tenet of geology is that a vast majority of the world's oil arose from tiny organisms at sea. Geologists estimate 95 percent or more of global oil traces its genesis to the sea. In part this is why, "For most areas, offshore offers the greatest potential," said William E. Galloway, an oil geologist at UT Austin. "We've been drilling wells for a hundred years and most of those have been on land. So the volumes that remain unexplored are primarily offshore in areas that have previously been inaccessible." The history of the Gulf of Mexico shows how many environmental factors came together to produce huge oil reserves. Scott W. Tinker, the state geologist of Texas and director of the Bureau of Economic Geology, said the abundant flows of mud and sediment into the gulf not only fed microscopic life but also formed rocky barriers that sealed off the organic remains from the outer world. "The organics got buried quickly because of the heavy sediment flow," said Tinker. "So they didn't get biodegraded as quickly. You preserved the organic richness." The flow was so heavy that growing accumulations keep pressing the lower sediment layers deeper into the earth, forcing them into hot zones where the organic material got transformed into oil. "The gulf has miles and miles of sediments," he said. "So that gets the source rocks down into the kitchen where they cook."

A Billion Years? So Yesterday

***Future Findings, U.S. News Service,* July 13, 2010**

For a series called "Time Scales," Tim Green talked to several researchers at UT Austin about the time scales in which they work. "I'm a structural geologist and I tackle tectonic problems," said Sharon Mosher, dean of the JSG. "I study everything from recent to plate boundaries that are 1.2 billion years old." For her, "recent" means five to 10 million years ago. But, she adds, 1.2 billion years ago is young in the total age of the Earth. "We go back to having records of events that are 4.5 billion years old on Earth," Mosher says. When a geologist talks about climate change or the extinction of species, those are things that have occurred over and over in Earth's history over periods of time, she said. "We're used to the idea that those things happen and you really have to watch geologists, you have to say, 'OK, but what about in a human time frame?' Because very commonly you'll get an answer and the people listening are thinking in a human time frame whereas the geologist is thinking millions of years."

BRIEFS

Martian Icecap, Now in 3-D

***Earth, Universe Today,* May 26-27, 2010**

Researchers have created the first 3-D subsurface pictures of Mars' northern icecap—and they're using these images to solve a 40-year-old Martian puzzle. The puzzle centered around Chasma Boreale, an ice canyon in the northern icecap comparable in size to the Grand Canyon, and the spiral troughs that extend in a pinwheel-fashion from the icecap's center. How these features formed has long mystified researchers. Jack Holt and Isaac Smith at the JSG's Institute for Geophysics and primary authors of two papers in *Nature*, used a shallow subsurface radar called SHARAD, an instrument on NASA's Mars Reconnaissance Orbiter. Holt and Smith conclude the subsurface structures they see in the SHARAD images are best explained by wind erosion. Holt says the images also provide clues to other Mars mysteries, changing "our view of how climate shapes and molds ice on Mars. We now know that ice deposition and modification are almost completely a climate process."

Oil Spill's Effects Discussed

***Austin American-Statesman,* May 19, 2010**

At UT Austin's Pickle Research Building, about 650 miles from the site of an oil spill endangering the Gulf of Mexico, university scholars convened to talk about the implications of the spill. The April 20 explosion of the Deepwater Horizon oil rig and its aftermath demonstrated how systems with safety redundancies can still fail, said Tad Patzek and Paul Bommer, who teach petroleum engineering. Sheridan Titman, a finance professor at UT's McCombs School of Business, said stock dips over the past month suggest the market is punishing deep-water drilling, rather than oil companies in general. But, Titman said, "I don't think we're going to decide we don't permanently want to drill in deep water. By drilling in the Gulf, we're limiting the monopoly power of OPEC, and there are economic reasons to do so." Among other environmental issues, the oil spill is putting attention on the delicate nature of the Louisiana wetlands. Should the spill infiltrate them, it could hasten the decades-long deterioration of a region that serves as a nursery for wildlife. "We're tending to deconstruct wetlands, not construct them," said Charles Groat, a professor at UT's JSG.

Charles Groat

Water-Energy: Trading One Problem for Another?

***Inside Renewable Energy,* March 4, 2010**

Renewables are considered more environmentally benign sources of energy. But when it comes to water use, many question the sustainability of certain technologies. With water shortages looming in countries all over the world, concerns are growing about how our transition to renewables will exacerbate those problems. Carey King, an energy and resource analyst for the Center for International Energy and Environmental Policy at UT Austin, describes which technologies use the most water, the benefits and drawbacks of dry cooling towers for power plants, and how U.S. water problems stack up with other countries around the world.

Sterling Nesbitt

Dinos May Be Older Than Thought

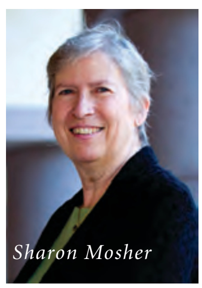
***U.S. News & World Report, Daily Telegraph (UK), AP, et. al,* March 3-4, 2010**

Paleontologists announced discovery of a dinosaur-like animal that shared characteristics with dinosaurs but fell just outside the dinosaur family tree living 10 million years earlier than the oldest known dinosaurs. Researchers conclude that dinosaurs and other close relatives such as pterosaurs might have lived much earlier than previously thought. The description of the new species *Asilisaurus kongwe* appears in the March 4 issue of *Nature* in a paper lead-authored by Sterling Nesbitt, a postdoctoral researcher at the JSG. The research suggests at least three times in the evolution of dinosaurs and their closest relatives, meat-eating animals evolved into animals with diets that included plants. These shifts all occurred in less than 10 million years, a relatively short time by geological standards.

Mosher Pursues Excellence

***Earth,* March 2010**

Earth magazine interviewed Sharon Mosher, dean of the JSG, to talk about the school's vision. Mosher stressed her twofold goals for the JSG, in education and research: "In terms of research, I've always felt that the future advances in the geosciences will come from discoveries at the interfaces between traditional disciplines. If we do interdisciplinary studies that investigate the interaction between physical, biological, and chemical processes and look at interactions among Earth's interior, surface, hydrosphere, biosphere, and atmosphere, we should be able to make major transformative discoveries within the Earth sciences." Mosher noted the school has done a lot in the past five years to advance its educational mission: increasing field experiences, redesigning the curriculum, enhancing professional skills for its students, and getting more research scientists from the



Sharon Mosher

In the News: Paul Mann & Haiti

***New York Times, BBC News, Agence France Press, and media outlets world-wide,* Jan. 12 to mid-March, 2010**

In March 2008 at the 18th Caribbean Geological Conference in Santo Domingo, Dominican Republic, Paul Mann, senior research scientist at the Jackson School's Institute for Geophysics, led a presentation (with co-presenters Eric Calais of Purdue University, Carol Prentice of USGS, and four others) outlining a major seismological hazard affecting the Dominican Republic, Haiti, and Jamaica. The hazard came from the Enriquillo-Plantain Garden strike-slip fault zone, which Mann knew well, having identified, studied, and named the zone years earlier during his dissertation research.

Paul Mann in Haiti.

Mann has continued monitoring the zone ever since. In 2008, he and colleagues foresaw danger. They forecast that due to accumulated strains along a boundary between tectonic plates, a region including Haiti, Jamaica and the Dominican Republic was due for an earthquake on the order of magnitude 7.2. Calais went on to lead-author a paper outlining aspects of the forecast in the July 17, 2008 edition of *Geophysical Journal International.*

At 4:53 p.m. local time on Tuesday, Jan. 12, 2010, a magnitude 7.0 earthquake struck near Haiti's capital city of Port-au-Prince. Due to poor building codes and a lack of emergency planning, the quake devastated the capital, killing more than 230,000 people and rendering one million homeless.

Within hours of the earthquake, Mann began receiving media calls. By the end of the first day, he was starting to get inundated. After news broke that Mann, Calais, and colleagues had nearly forecast the event two years earlier, Mann began a roller coaster ride of inquiries that lasted for weeks. To cope with the volume of requests, he had the school media team post a Web site with answers to the most common questions and a guide to resources for more information. Mann and colleagues at the Institute fed information to the site daily, sometimes hourly, until it became one of the best guides on the Web to geological information on the quake.

Media relations professionals often use Google News to track the amount of coverage a person or event receives. In a typical, widely breaking science story, the lead scientist might show up in about 100 articles on Google News. Even wider stories might net 200 or 300 stories, and the top science stories of the year a few more still.

At the height of the Haiti coverage, Mann appeared in more than 6,000 articles.

He did not relish the attention, because of its cause. As Mann explained to many who spoke with him in the aftermath of the quake, it was not a good feeling to know he had been right about such a major disaster. In the weeks and months after the quake, Mann and Institute colleagues made rapid response trips to Haiti to understand the seismic hazard as fully as possible—and help ensure the greatest degree of communication and future geohazard preparation for the region's residents.

Mann is a big believer in communicating science and working with local scientists in hazard-prone regions, in part to increase chances of acheiving regional awareness of hazards. As he says in our feature article on the rapid response missions to Haiti, "As scientists we cannot live in an ivory tower since many lives depend on the information we possess."

The Jakarta Post
WORLD
HAITI
Scientists warned officials of quake in 2008
Rick Callahan
ASSOCIATED PRESS
INDIANAPOLIS, INDIANA

HIGHER EDUCATION
UNIVERSITY OF TEXAS

SCIENTISTS STUDYING HAITI FOR EARTHQUAKE RISKS

Scientists at UT's Institute for Geophysics, a unit of the Jackson School of Geosciences, will visit Haiti to assess the potential of additional earthquakes in the area. The Jan. 12 quake caused widespread death and devastation in the impoverished nation.

Researchers from Purdue University, the U.S. Geological Survey, Columbia University's Lamont-Doherty Earth Observatory and five other institutions also are participating in the field work. Teams are using a research vessel to examine the underwater effects of the quake. The scientists also will study dead coral for clues to recent and historical uplifts, according to a UT news release.

"We expect a whole raft of studies about the Haiti earthquake coming out based on remote-sensing data from satellites and airplanes," said Sean Gulick of the Institute for Geophysics. "But there's no substitute for getting on the ground and in the water to look directly at its immediate effects."

Other institute researchers with leadership roles in the expeditions include Paul Mann and Fred Taylor.

Los científicos alertan que lo peor aún puede estar por llegar

Institute for Geophysics and the Bureau of Economic Geology involved with students. "In the future, I want to foster a greater focus on research excellence among students, both at the undergrad and grad level," said Mosher, "really strengthen our Ph.D. program, and provide a more wellrounded undergraduate program."

Protect Public Helium Reserve

***Wall Street Journal,* Feb. 26, 2010**

The ongoing sell-off of federal helium supplies is no longer in the public interest, scientists told U.S. lawmakers. Congress passed legislation in 1996 ordering the Interior Department to sell off the federal government's 30 billion-plus cubic feet of helium. But selling the reserve now jeopardizes affordable supplies of helium. And while demand has expanded, private suppliers have not always kept up, said Charles Groat of the JSG, who co-chaired a National Research Council report on the helium reserve. The report asked federal officials to sell helium only at market rates, instead of at an arbitrary price set by Congress. If current conditions continue, the United States will be importing helium from the Middle East and Russia within 15 years, Groat said.

INDUSTRY ICONS

SCOTT W. TINKER:
STRENGTHENING CONNECTIONS

Scientists Reveal Flamboyant Colors of Dinosaur's Feathers

***New York Times, National Geographic, AP, et. al,* Feb. 4-6, 2010**

Deciphering microscopic clues hidden within fossils, scientists have uncovered the vibrant colors of a feathered dinosaur extinct for 150 million years, as reported Feb. 4 in *Science*. The analysis of melanosomes was so precise the team was able to assign colors to individual feathers of *Anchiornis huxleyi*, a four-winged troodontid dinosaur that lived during the late Jurassic period in China. This dinosaur sported a generally gray body, a reddish-brown, Mohawk-like crest and facial speckles, and white feathers on its wings and legs, with bold black-spangled tips. Richard O. Prum of Yale University co-authored the paper with Yale graduate student Jakob Vinther and colleagues, including Julia Clarke of the JSG. The research adds significant weight to the idea dinosaurs first evolved feathers not for flight but for some other purposes, since when elgongate feathers first appear in the fossil record, they are already spotted and striped, noted Clarke. "This means a color-patterning function—for example, camouflage or display—must have had a key role in the early evolution of feathers in dinosaurs, and was just as important as evolving flight or improved aerodynamic function," Clarke said.

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The New York Times

Science

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Evidence Builds on Color of Dinosaurs

National Geographic

An illustration showing the likely colors of Anchiornis huxleyi.

By CARL ZIMMER

Published: February 4, 2010

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REPRINTS

Until last week, paleontologists could offer no clear-cut evidence for the color of dinosaurs. Then researchers provided evidence that a dinosaur called Sinosauropteryx had a white-and-ginger striped tail. And now a team of paleontologists has published a full-body portrait of another dinosaur, in striking plumage that would have delighted

Tinker Cited as Industry Icon

***Oil & Gas Investor,* January 2010**

The January 2010 issue of *Oil & Gas Reporter* included a laudatory profile of Bureau Director Scott Tinker, described as an "industry icon" for the energy business. "As director of the Bureau of Economic Geology, University of Texas at Austin, and State Geologist of Texas," report the editors, "Scott Tinker is a respected voice and thoughtleader both within and outside the industry. His passion is to work with industry, government and academia to strengthen the connections between energy, the environment and the economy." The article also mentioned Tinker's work on a documentary film on global energy with Harry Lynch, an award-winning filmmaker. The $3-million project is due out in 2010 or 2011. "Our goal is for the broad public to see all forms of energy in their best light, and be able to understand the scale, infrastructure, challenges, and intricacies of global energy," said Tinker.

CO_2 Projects Change Debate

***Dow Jones Newswires,* Dec. 15, 2009**

While many scientists follow the lead of U.S. Undersecretary of Energy Stephen Chu, who voices confidence in the future of carbon capture and storage (CCS), University of Houston Professor Michael Economides has made an issue of his belief CCS is not economically or geologically feasible. Meanwhile, world-wide efforts to assess carbon sequestration are increasing, putting facts and figures behind claims in favor of the technology. As of November 2009, the U.S. Department of Energy said there are eight active CCS projects. One is designed to inject naturally occurring CO_2 into an oilfield in Cranfield, Miss., testing the Southeastern subsoil's ability to retain the gas. The DOE said that as of late September, the project had 1.2 million tons of CO_2 in the ground. "So far, so good," says Susan Hovorka of the JSG's Bureau of Economic Geology and a leading authority on carbon sequestration working at the Cranfield project. She said that “unequivocally” there is enough space to hold large quantities of CO_2. However, it will be costly and it may not be wise to rely on sequestration as the sole, permanent solution.

Meat-Eating Dinosaur Alters Family Tree

***New York Times, USA Today, Houston Chronicle, et. al,* Dec. 10-12, 2009**

Newly described dinosaur fossils from New Mexico are helping scientists better understand the early development of these ancient creatures. The 6- to 12 foot-long, meat-eating creature, Tawa hallae, is described in *Science* in a paper lead-authored by Sterling Nesbitt, postdoctoral reseaarcher at the JSG. The first dinosaurs developed about 230 million years ago, and *Tawa* skeletons date from about 213 million years ago, reports Nesbitt. “*Tawa* gives us an unprecedented window into early dinosaur evolution, solidifying the relationships of early dinosaurs, revealing how they spread across the globe, and providing new insights into the evolution of their characteristics,” Nesbitt said. It developed on the supercontinent Pangea, in which creatures could move from region to region before Pangea broke apart into the current continents. Nesbitt added that the find may reinforce the idea that dinosaurs originated in what is now South America and then moved on to other regions.

Sue Hovorka

Long-Stable East Antarctica Losing Ice

***New York Times, Reuters, AFP, et. al,* Nov. 22-23, 2009**

In a story reported worldwide, scientists at UT Austin’s Center for Space Research, including JSG Professor Clark Wilson (co-author) and JSG Ph.D. graduate Jianli Chen (lead author), report a reversal in the status of East Antarctica. For years scientists have observed that the East Antarctic ice sheet—which holds about five times as much ice as West Antarctica and Greenland combined—has been growing in size. Increased precipitation from a warming world combined with the region’s extreme cold appeared to allow increased snowfall to accumulate indefinitely. But a study in *Nature Geoscience* suggests this growth spurt may have come to an end. Starting in about 2006, says Chen, East Antarctica started declining, just like the world’s other great ice sheets. “The amount [of decline] right now isn’t very big, but the trend is alarming,” he says. The best guess on the decline is about 57 billion tons per year, but with a huge uncertainty of plus or minus 52 billion because Chen and his colleagues working the data from NASA’s GRACE satellite program had to factor in Post Glacial Rebound.

Alternative Energy Sources Can Be Water Hogs

***New York Times,* Sept. 30, 2009**

Here is an inconvenient truth about renewable energy: It can demand a huge amount of water. Many of the proposed solutions to the nation’s energy problems, from certain types of solar farms to biofuel refineries, could consume billions of gallons of water every year. “When push comes to shove, water could become the real throttle on renewable energy,” said Michael Webber, associate director of the Center for International Energy and Environmental Policy at UT Austin, who studies the relationship between energy and water. Conflicts over water could shape the future of many energy technologies. The most water-efficient renewable technologies are not necessarily the most economical, but water shortages could give them a competitive edge.

Mead Allison, winner of the 2010 Walter Excellence Award at the Jackson School.

AWARDS & HONORS 2009-2010

All awards are for the 2009-2010 academic year unless otherwise noted.

Faculty & Researchers

Mead Allison
Walter Excellence Award, JSG

William Ambrose
Distinguished Service Award, Energy Minerals Division of American Association of Petroleum Geologists

Jay Banner
JSG Outstanding Educator Award, JSG

Jaime Barnes
Outstanding Woman in Science Award, Subaru & Geological Society of America
G. Moses and Carolyn G. Knebel Distinguished Teaching Award, JSG

Frank Brown
Sidney Powers Memorial Award, American Association of Petroleum Geologists

Martin Jackson

Award-Winning Researcher Follows His Interests

Exceprt from March 2010 **AAPG Explorer** *profile by Barry Friedman.*

Martin Jackson, this year's winner of AAPG's Robert R. Berg Award for Outstanding Research, would have been a lousy doctor.

It almost happened.

"My early inclination," Jackson says, "was to medicine."

So what happened? Did his focus change to salt tectonics after enrolling in some geology course on a lark? Or was it a family field trip that revealed the wonders and mysteries of the earth?

Neither.

"I wasn't clever enough," he said of his goal of medicine, "so I settled for biology instead, aiming for marine biology, partly because a life by or on the sea was attractive after growing up in a landlocked country." Jackson, who is among the geosciences award-winning legends at AAPG, was born in Rhodesia (now Zimbabwe).

But it wasn't until he was completely done with medicine aspirations (or vice versa) that he took the obligatory geology course that changed his focus.

"At university," Jackson says, "I added geology as a filler course—then discovered I had an aptitude for it."

"The combination of freedom and stimulation in research has been unbeatable," he continued, "including exploration (physical adventure and the mental roving), piecing a story together, the satisfaction of using a drawing to think, the craft of writing, and finally the encouragement to tell a geological story to others."

Jackson, now senior research scientist at the Bureau of Economic Geology, especially emphasizes writing and publication.

"Unless academic research is published, it's essentially useless and little more than self-gratification," he said. "Only after publication can it be evaluated and tested and put to use if it's any good."

Bayani Cardenas
CAREER Award, National Science Foundation
G. Moses and Carolyn G. Knebel Distinguished Teaching Award (Undergraduate), JSG

William Carlson
Professor of the Month (Jan. 2010), Senate of College Councils

Kerry Cook
Fellow, American Meteorological Society

Bruce Cutright
Phoenix Award, Midtown Miami Project

Shirley Dutton
JSG Research Excellence Award, JSG

Peter Eichhubl
Most Cited Article of the Last 5 Years (co-author), *Journal of Structural Geology*

Bill Fisher
2010 Colonel Edwin L. Drake Legendary Oilman Award, Petroleum History Institute

Sergey Fomel
Top 30 Presentation, Annual meeting Society of Exploration Geophysicists

William Galloway
Twenhofel Medal, SEPM

Bob Hardage
Distinguished Service Award, American Association of Petroleum Geologists

Lundelius Honored with Special Issue of *Quaternary International*

Quaternary International dedicated its April 25, 2010 edition (Vol. 217, issues 1-2) to Jackson School Emeritus Professor Ernest Lundelius. Eric Scott of the San Bernardino County Museum and Greg McDonald of the National Park Service edited the volume, "Faunal Dynamics and Extinction in the Quaternary: Studies in Honor of Ernest L. Lundelius, Jr.." The volume originated from a symposium honoring Lundelius at the 2007 national meeting of the Society of Vertebrate Paleontology, held in Austin. Authors include several of the 24 doctoral students Lundelius supervised during his career and many of his professional colleagues, including Jackson School Professor Chris Bell.

Of note to Lundelius fans, the volume includes a biographical portrait of Lundelius by Pamela Owen of the Texas Memorial Museum. "It has been said that Texas shapes the lives of its inhabitants, and often produces 'larger than life' characters," writes Owen. "'Ernie' fills those boots. Born in Austin, Texas on the 2nd of December 1927, Ernie began a life-long study of Texas natural history that continues till today. As a child, Ernie collected his first fossil, a Cretaceous oyster, still on display on the fireplace in his home." Noting the ongoing relevance of Lundelius' recent scholarship, Owen describes it as "the primary reference for Pliocene though Pleistocene mammalian faunal succession—much like Ernie himself."

Tricia Alvarez with Paul Mann

Honorary Lecturer, Society of Exploration Geophysicists
Award of Appreciation, Society of Exploration Geophysicists

Martin Jackson
Robert R. Berg Outstanding Research Award, American Association of Petroleum Geologists

Farzam Javadpour
Best Paper Award, Journal of Canadian Petroleum Technology

Steve Laubach
Award of Appreciation, Outstanding Technical Editor, Society of Petroleum Engineers

Ernie Lundelius
Dedicated Issue (April 25, 2010), *Quaternary International*

Lorena Moscardelli
BEG Publication Award (2010), Bureau of Economic Geology/JSG

Bob Reedy
BEG Publication Award (2009), Bureau of Economic Geology/JSG

Bridget Scanlon
BEG Publication Award (2009), Bureau of Economic Geology/JSG

Ron Steel
G. Moses and Carolyn G. Knebel Distinguished Teaching Award (Graduate), JSG

Lesli Wood
BEG Publication Award (2010), Bureau of Economic Geology/JSG

Promotions

Chris Bell
Professor, Department of Geological Sciences

Donald Blankenship
Senior Research Scientist, Institute for Geophysics

Gail Christeson
Senior Research Scientist, Institute for Geophysics

Xavier Janson
Research Scientist, Bureau of Economic Geology

Leadership Positions

James Austin
Member of the Corporation, Woods Hole Oceanographic Institution

Ruarri Day-Stirrat
Editor, SEPM Sedimentary Record

Bob Hardage
First Vice President of the Executive Committee, Society of Exploration Geophysicists

Xavier Janson
Editor, SEPM Sedimentary Record

Steve Laubach
Associate Editor, *SPE Reservoir Evaluation & Engineering*, Society of Petroleum Engineers

Terry Quinn
Executive Committee, Science Advisory Structure, Integrated Ocean Drilling Program

Wayne Wright
Editor, *SEPM Sedimentary Record*

Galloway Wins Twenhofel Model, SEPM's Highest Award

The SEPM Society for Sedimentary Geology awarded Bill Galloway the Twenhofel Medal at the 2010 Annual AAPG-SEPM Meeting in New Orleans. Galloway was nominated by many of his ex-students for the award. He joins the ranks of Bill Fisher (2001) and Bob Folk (1979) as faculty members from the Jackson School's Department of Geological Sciences who were awarded the medal.

The Twenhofel Medal is the highest award of the SEPM Society for Sedimentary Geology. The award recognizes "outstanding contributions to sedimentary geology." According to SEPM, nominees are chosen "who are recognized as having made outstanding contributions to paleontology, sedimentology, stratigraphy, and/or allied scientific disciplines. The contributions will normally involve extensive personal research, but may involve some combination of research, teaching, administration, or other activities which have notably advanced scientific knowledge in sedimentary geology. A record of sustained high achievement is an essential qualification. Candidates shall be selected from the entire scientific community of sedimentary geologists and are not to be limited to members of any society in particular, nor to citizens of any one country."

Congratulations to Bill Galloway for receiving the society's highest mark of distinction!

Students

Tricia Alvarez
Third Place, Student Poster Session, American Association of Petroleum Geologists (2010)

Rebecca Comeaux
Tech Sessions Best Speaker, JSG

Gareth Cross
Speaker, Austin Geological Society

Anmar Davila-Chacon
1st Place Team, Day 2, 2010 BP Energy Play at UT Competition

Kathryn Dianiska
Petrography Contest, 1st place (Undergraduate), JSG

John Hooker
Recognition Award, La Asociación Mexicana de Geólogos Petroleros

David Hull
2nd place, Imperial Barrel Award Competition, Gulf Coast Association of Geological Societies sectional

Jamie Levine
Outstanding Teaching Assistant, JSG

Vishal Maharaj
Selected for 2009 Student Oral Awards Competition, AAPG
Thomas A. Philpott Excellence of Presentation Award (2009), Gulf Coast Association of Geological Societies
2nd Place, Imperial Barrel Regional Competition (March 2010), AAPG

Kylara Martin
Outstanding Teaching Assistant, JSG

Jessica Morgan
Selected for 2010 Student Oral Awards Competition, American Association of Petroleum Geologists

Jeffrey Nittrouer
Tech Sessions Best Speaker, JSG

John Nowinski
Tech Sessions Best Speaker, JSG

Toby Powell
Outstanding Teaching Assistant, JSG

Bobby Reece
Day 1, 1st Place Team, 2010 BP Energy Play at UT Competition
Outstanding Student Paper Award, American Geophysical Union

Derek Sawyer
Tech Sessions Best Speaker, JSG

Julia Schneider
Outstanding Teaching Assistant, JSG

Isaac Smith
Outstanding Student Paper Award, American Geophysical Union

Evan Strickland
Estwing Hammer Award, JSG

Travis Swanson
Tech Sessions Best Speaker, JSG

Lindsay Szramek
Petrography Contest, 1st place (Graduate), JSG

Kyle Womack
Student Service Award, JSG Graduate Student Executive Committee

Staff

Angela Angelo
Outstanding Staff Award, UT Austin

Julie Duiker
JSG Staff Excellence Award, JSG

Jeffrey Horowitz
30 Years of Service Award, UT Austin

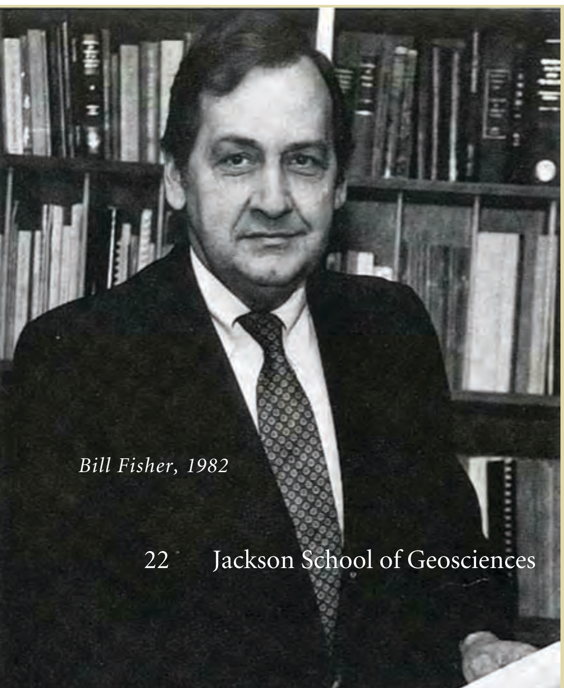
Jennifer Lee
Thelma Lynn Guion Library Staff Award, JSG

Jessica Maisano
10 Years of Service Award, UT Austin

David Melanson
Thelma Lynn Guion Library Staff Award, JSG

Greg Thompson
20 Years of Service Award, UT Austin

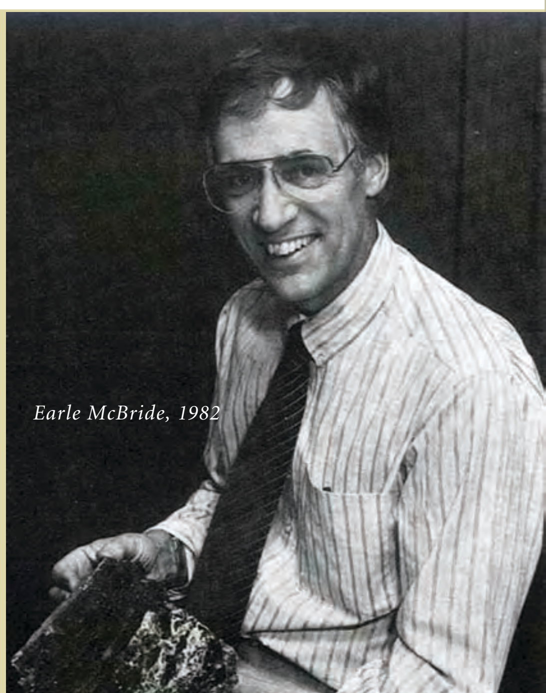
Renee Waters
JSG Outstanding Service Award, JSG



Bill Fisher, 1982

Fisher, McBride Celebrate 50 Years of Geosciences at UT

This year marked the 50-year anniversary of service for two of the Jackson School's most distinguished professors and scientists: Bill Fisher and Earl McBride. Both are shown here in 1982 when they received chairs. Fisher, who was honored this year with the Colonel Edwin L. Drake Legendary Oilman Award, in 1982 became the Morgan J. Davis Centennial Professor in Petroleum Geology. (Today he is the Leonidas T. Barrow Centennial Chair in Mineral Resources.) McBride became the Wilton E. Scott Centennial Professor in Geology. Today he is an emeritus professor. Congratulations on 50 great years!



Earle McBride, 1982

AAPG Recognizes Brown with Top Honor, Sydney Powers Medal

by David Brown / *AAPG Explorer*

Only one AAPG member went on record to question the choice of L. Frank Brown Jr. as recipient of the 2010 Sidney Powers Memorial Award, the association's most distinguished honor. That was L. Frank Brown Jr.

"I'm sort of surprised that I would be singled out in petroleum geology," he admitted.

There's no doubt, Brown would be more comfortable with the title of Practical Geologist or even General Stratigrapher. There's also no doubt his work helped change the way petroleum geology and exploration is done around the world.

An emeritus professor at the Jackson School and senior research fellow at the Bureau of Economic Geology, Brown is known as a key developer of concepts in depositional systems, seismic stratigraphy, and sequence stratigraphy.

William Fisher, a past Sidney Powers medalist and longtime collaborator with Brown, called him one of the world's top stratigraphers. He developed today's fundamental approach to describing depositional packages and introduced advanced stratigraphic concepts around the world in part through AAPG lectures, short courses, and publications. And along the way he helped upend some dubious thinking in geology.

For example, he showed prevailing geological theory about the mature Woodbine Field area in Texas was off the mark. As a result, waterflooding efforts in the field weren't draining the reservoir efficiently.

"Those fellows over in East Texas were just bumfuzzled because their ideas turned out to be incorrect," Brown said.

That work led to a string of discoveries by operators.

Bed Time in Brazil

Changes in geological thinking during Brown's 55-year career have amounted to nothing less than a revolution, in his view.

"I sort of bridged the gap from the old timers before World War II—when stratigraphy was considered boring and involved a lot of memorization—through a revolution where almost all the majors established research labs," Brown said.

"Everything that happened from that period through the 1950s up to today was very controversial at the time," he added. "The old timers didn't want to change their way of thinking. For the most part, people now have accepted what happened."

Out of all his international geological consulting work, including visits to 25 countries, Brown is probably best known for his efforts in Brazil.

"Bill Fisher and I were working with Petrobras for about 10 years," Brown recalled. "That got us into collaboration with Peter Vail and with Bob Mitchum and those guys over at Exxon.

"In that period, I'd work a basin and he'd work a basin. We insisted that they send two or three people up to Austin every year—not to go to school, but to rent space at the university and to work on real problems in these basins," he said.

Fisher described one experience with Brown when the two were consulting with Petrobras. The company had arranged accommodations at a good hotel in Rio de Janeiro, in the Copacabana area. They decided to travel to Brazil's Bahia region for fieldwork and returned to Rio one night at about 1 a.m. The hotel could provide only one room, with a double bed—and not enough space for all their luggage.

Fisher, Brown and a suitcase shared the bed that night. The next day, Petrobras executives asked about their hotel stay. They said their quarters were marginal, at best. When the pair returned that evening, "they had the entire suite on the top of that hotel reserved for us, with an open bar," Fisher recalled. "Our colleagues would remark how well Petrobras was treating us.

"Frank said, 'All you have to do is find them a little oil, and look what you get,'" he said.

Almost everyone knows the ultimate ending to this story. The work done by Brown and Fisher helped Petrobras find much more than "a little oil."

The Practical Geologist

After earning his first degree cum laude at Baylor, Brown attended the University of Wisconsin and received his doctorate in geology in 1955. Having grown up in the oil patch in Oklahoma, he early on felt petroleum geology would be a good way to make a living.

He landed his first job in the industry in Amarillo, Texas, which led to an initial stint with the Bureau in Austin. After six years teaching geology at Baylor, he returned to the Bureau to begin a decades-long, fruitful collaboration with Fisher and other scientists.

"Frank introduced the concept of system tracks—we called them depositional system tracks in those days. That has become the fundamental way of describing depositional packages," Fisher said.

As a 50-year colleague, Fisher admires Brown's "exceptionally keen perception. That's why he was early on one of the leaders in seismic stratigraphy. He could see things in the data that nobody else could see."

Brown also brought a willingness to keep learning to his research.

"I've learned a lot I didn't know before by seeing basins all over the world," he said.

The word Brown uses most often to describe his work is "practical," and he considers himself more of an intuitive, big-picture researcher than an analyst.

"I'm a right-brainer, not a left-brainer like a lot of these scientists are," he explained. "I'm more of an integrator and a geology historian."

This article originally appeared in the April 2010 edition of AAPG Explorer *and is edited and reprinted with permission.*

Undergraduate Steven Gohlke (front right) of the Reptar Resources team answers questions from the judges during the 2010 simulated lease sale competition.

BRIEFS

Hands-On Learning Monopoly: Oil Edition

When the 125 geoscience and engineering students in the course Petroleum Geology: Basin and Trend Analysis returned from Spring Break, they had the chance to take part in the mother of all Monopoly games.

The students were asked to form imaginary oil and gas companies and conduct a hydrocarbon assessment of an area in the Gulf of Mexico. Chevron supplied them with real world seismic and well log data. The "bank" gave each team a total of $250 million of play money to do their analysis (they could buy extra seismic data, for example) and to bid on leases. At the end of five weeks, they would select blocks to bid on in an imaginary federal lease sale. Judges from Chevron, as well as the instructors and TAs for the course, would select the winners.

Peter Flemings, who developed the course with co-instructors Ron Steel and Xavier Janson, said the lease sale sprouted from his strong conviction that students learn the best when they're solving problems.

"We can talk all day about concepts in class," said Flemings, "but I believe it's the act of forcing the student to take the information and make a map and integrate different information that forces the learning."

Students came up with team names that ranged from the authentic sounding (Imperial Oil & Gas), to the school spirit-filled (Bevo Oil & Gas), to the whimsical (Enron 2.0, Graben Goblins, and Reptar Resources).

The project gives students a taste of life working in the oil industry. They use real data from a region that has actually produced significant amounts of oil. They follow industry methods for analyzing the data, assessing risk, estimating costs, and establishing lease bids. Perhaps most importantly, said Flemings, they work in mixed teams with earth scientists and petroleum engineers.

"This is an environment that is extremely common in industry, where engineers and geoscientists have to work together, but I don't think it happens much in college," he said. "It's certainly one of the first formative experiences where those folks have to learn together."

"The best part was the interdisciplinary team work," said Steven Gohlke, Undergraduate Geological Society chapter president and member of the Reptar Resources team. "That's something I'll deal with every day at work in industry. We come at things from a different perspective and that's a good thing. It made our prospect better. No other class gets us working together like this."

At the end of the five weeks, a maze of posters snaked through the ground floor hallways of the geosciences building. Then starting at 8 a.m. on a Tuesday morning and continuing well past 4 p.m., the instructors, teaching assistants, and three guest judges from Chevron interrogated the 27 teams in what seemed like an unending blitz of 15 minute speed dates.

The next day, the students poured into the lecture hall to hear the results.

The judges revealed the area the students had analyzed for five weeks was the Greater Tiger Shoal Area, a world class field. They noted that most teams focused on one location that was indeed a good target, but missed three or four other much more valuable fields in the area. For the field they did focus on, they tended to overestimate reserves, which led them to overbid for lease blocks. But overall, the judges were impressed with the thought and hard work the students put into the project. The winning team was Premier Coastal Exploration.

The class is designed to give students a leg up in the competitive oil industry. Chevron also considered it a smart investment of their time and energy.

"We do take notes on individuals who stand out and pass those on to our recruiters," said Ellen Clark, geophysicist with Chevron. "It also helps the students get to know Chevron and our personality. For me personally, I enjoy getting to meet the students and see their unbridled enthusiasm for the oil industry."

The course will be offered again in 2011.

LIBRARY REPORT

By Dennis Trombatore

Outfall from the economic crisis continues to influence planning and operations for the university and the libraries. The UT Library is under a partial hiring freeze, which has disturbed operations, since most of the open positions will likely be lost. Last year the libraries reduced monograph purchases by $100,000, and database services by $50,000, and some of our vendors are being hit by the turndown as well, causing concern for continuity of services. The 5 percent budget reduction, followed by the threat (as yet) of another potential 10 percent cut in state appropriations has the libraries in contingency planning for deep cuts to journal and database expenditures. Endowment earnings have not, as yet, been significantly reduced, but multiyear averaging will begin to decline next year as well, so in the Walter Library we are "battening down the hatches" and hoping to weather the storm that is late to break upon us.

Library endowments were established to provide resources for excellence. In these times, the funds may be required to help support day-to-day expenditures. It may be that the current economic difficulties require the re-definition of day-to-day, but the definition of excellence has not changed. Operating a first class information resource for teaching and research requires both good information content and skilled people to organize, manage, and teach it. It isn't cheap. As in the early '90s, when we had our last major serials cancellations, we will have the best library we can afford, and it will continue to be better than most. We are grateful this past year for endowment donations from Mrs. Elizabeth Keeney, Michael Wiley, and Ernie Lundelius, among others. Thanks also to Chris Bell, who is serving as chair of the University Library Committee.

Meanwhile, we have been busy on a number of fronts. This past year we significantly improved our online access to historical journals published by Wiley/Blackwell. For an investment of $38,000, we were able to get complete e-backfiles access for 23 titles, including several important climate journals, with no annual maintenance fees. Kudos to Gary Kocurek for funding two titles from his chair! The next step is to begin transferring some of the journals that are reliably available online to storage to make some additional room in the collection. Processing of the ARCO library gift has finally been completed; we added several thousand items from that large gift, and the materials are in demand, especially for interlibrary loan.

The Virtual Landscapes of Texas (http://www.lib.utexas.edu/books/landscapes/) free online full text documents file continues to grow, and with the size of the file comes growing pains. We are in the middle of a complete redesign to make the site more consistent, easier to use, and better indexed. More than fifty new titles have been added this year, including all six volumes of the *Environmental Geologic Atlas of the Texas Coastal Zone*, and the classics *Texas Fossils*, and *Texas Rocks and Minerals*. This brings the total file to almost 500 titles. We have also digitized a number of older theses thanks to permissions granted at the reunions the past several years. These were loaded into the new UT Digital Repository (http://repositories.lib.utexas.edu/) site for the new UT digital theses and dissertations files, where we have also added 34 power point presentations of Dan Barker's volcanology field photographs.

This past year we tried some new outreach efforts, including a summer class at Pickle, the library fair, a new orientation for incoming EER students, and giving tours for the reunion, parent's weekend, and freshman orientation. These were all intended to raise awareness of services and collections available to various user groups. I was invited to TCEQ to give a presentation on harvesting information from internet sources, and I gave a presentation on the history of the Walter Library to a library forum. This will eventually become an addendum to our web pages.

In staff and student news, I-School student Caitlyn Lam was hired by UT Tyler, Betsy Young is now working at ACC, and this year's GRA Sheri Miklaski has completed the cataloging of all 2300-plus USGS *Water Supply Papers*, and has been creating original cataloging records for some of our more unusual materials. Meredith Bush is at Exxon Library for a summer internship, and will return in the fall as our GRA. Calla Smith-Dowling completed a RUSA online professional development seminar on the Reference Interview, and in addition to her regular duties, is supervising much of the *Virtual Landscapes* redesign. Calla also completed a tutorial, "Conducting Geological Research," (http://www.lib.utexas.edu/geo/tutorial.html) for our web site. I completed my term on the GeoScience World Advisory Committee, and continue as chair of the GeoRef Advisory Committee for AGI. This year's Thelma Guion Library Staff Awards went to Jennifer Lee, Head of Preservation Services, for her work coordinating *Virtual Landscapes* digitizing efforts, and David Melanson, serials cataloger, for his training and supervision of our GRA. Pat Dickerson continues sharing space in the library as an indexer for AGI/GeoRef; she has also traveled to Argentina, and continues her field work in West Texas.

Frontiers of Geochemistry:

JAIME BARNES BREAKS NEW GROUND IN USE OF CHLORINE ISOTOPES

Jaime Barnes is happy to be back home. A San Antonio native who received her bachelor's degree from The University of Texas at Austin, Barnes left the Lone Star State to pursue her graduate education. Now, the assistant professor at the Jackson School of Geosciences returns to Austin having built an impressive standing in the field of geochemistry for her groundbreaking work with chlorine isotopes.

Barnes studies high-temperature fluid-rock interactions. The research she began as a doctoral student at the University of New Mexico focuses on serpentinites, hydrated pieces of the ocean crust. Serpentinites have recently come into vogue among geoscientists as indicators of volcanic and earthquake activity related to subduction zones. The rock contains a great deal of water and when it dehydrates— as a result of sinking to certain depths through the subduction of ocean slabs, for instance—it releases a lot of fluids that can include chlorine and other highly saline yet soluble elements.

Using ocean drill cores obtained through the Integrated Ocean Drilling Program, Barnes has analyzed samples for chlorine isotopes and then tracked the origin and concentration of serpentinites, and whether they are feeding into (or off of) volcanoes, or triggering earthquakes. She has also taken a more direct approach, collecting samples from Poás Volcano in Costa Rica.

Jaime Barnes

Within the field of geochemistry, chlorine isotopes have rarely been used for this purpose, compared with oxygen or hydrogen isotopes, "probably because they're a pain in the butt," Barnes jokes. Scientists first measured chlorine isotope ratios in the 1960s, but the method to extract chlorine from rock and turn it into a gas to analyze in a mass spectrometer is complex.

"There's a lot of chemistry involved and it's not easy," Barnes says, "and the gas that they were sticking into the mass spectrometer was hydrochloric acid, which is not the best thing to stick into an analytical instrument. You produce this nasty gas and then the precision wasn't very good and didn't look like it was going to tell you all that much."

In the 1990s, geochemists figured out a way to measure chlorine isotopes without creating hydrochloric acid while improving the precision, but few researchers jumped at the advances. So when Barnes came along in search of a tracer for serpentinites, she practically had the discipline to herself.

Barnes spent two years learning extraction and purification methods for the chlorine isotopes, until she was able to accurately analyze the trace amounts present in rocks and minerals. Part of her doctoral research, in collaboration with advisers and colleagues, contributed to a better understanding of the cycling of chlorine and its isotope composition among the planet's mantle, crust, and meteorites.

"I've been very busy with it, and people seem to be very interested now partly

New Faculty Hires, 2008-2010

The Jackson School has hired and retained 16 new faculty members since the start of the 2008-09 academic year. We profiled the first batch in the 2008 *Newsletter*, six more in 2009, and complete the group in this issue.

Climate Systems Science

Dan Breecker* / Assistant Professor

Kerry Cook / Professor

Robert Dickinson / Professor and Jackson Scholar

Rong Fu / Professor

Tim Shanahan / Assistant Professor

Earth Surface and Hydrologic Processes

Ginny Catania / Assistant Professor

Joel Johnson* / Assistant Professor

Wonsuck Kim / Assistant Professor

Crust, Mantle & Core Dynamics

Jaime Barnes* / Assistant Professor

Liz Catlos* / Associate Professor

Rich Ketcham / Associate Professor

Luc Lavier / Assistant Professor

Afu Lin / Assistant Professor

Energy Geoscience

Marc Hesse* / Assistant Professor

Kyle Spikes* / Assistant Professor

Paleontology

Julia Clarke / Associate Professor

* Profiled in this issue

because there's a lot of interest in serpentinites and subduction zones, and also the chemistry of saline fluids," Barnes says. "There's not that much that's been done on it, so it's kind of a wide-open field."

Her pursuits into a less-explored corner of the geosciences have rightfully earned Barnes recognition from her peers. She won the L'Oreal USA for Women in Science Fellowship as she was completing her doctorate degree. In 2009, the Geological Society of America presented her the Outstanding Woman in Science Award, an annual honor bestowed to women whose doctoral research has a profound impact in the field of geosciences.

Barnes says the awards have led to exciting collaborations with other researchers from around the world, particularly those who want to tap into her experience with chlorine isotopes. At the Jackson School, the mass spectrometer that Barnes uses in her lab is one of just a few in the world configured for chlorine isotopes. She also recognizes that she is among a few women working in a field traditionally dominated by men, and she hopes to encourage Texas students to strike off on their own pioneering paths in the geosciences.

Among her ongoing projects, Barnes is studying the chlorine composition of lunar rocks, which have very a different isotope value than terrestrial samples, which puzzles geoscientists.

"The moon was created from a large impact, smacking into the Earth, and then the material coalesced to form the moon, so why is the chlorine composition so different?" Barnes says. "What does that tell us about the formation of the moon?"

She also plans to investigate whether she can use chlorine, which often bonds with metals, to trace the original sources of economic ore deposits.

"I end up doing a lot of chlorine work primarily because there's not a whole lot of labs that do it," Barnes says. "It has started out with this little trail, and it's become bigger and bigger."

Of course, back home in Texas, everything is bigger, as they say, and Barnes is poised for grand opportunities at the Jackson School. ✷

– *Joshua Zaffos*

Dan Breecker

Reversing Expectations:

DAN BREECKER LOOKS TO THE PRESENT TO UNDERSTAND THE PAST

Most geologists can be forgiven for living in the past, but Dan Breecker is making a point of keeping focused on the present. Breecker, who joined the Jackson School of Geosciences as an assistant professor in 2009, concentrates on the interactions between climates, soils, and carbon dioxide (CO_2) levels, and his research is helping to improve our understanding of historical and current climate change.

As a doctoral student at the University of New Mexico, Breecker began studying the formation of soil carbonates, which are rocks or minerals, such as calcite, found in the ground and dominated by carbon-based ions. Working with colleagues, he took measurements from modern soils from New Mexico to Saskatchewan, Canada to determine how and when during each year the carbonates formed. Then the geoscientists used stable isotope composition to compare them with estimated levels from the planet's hottest "greenhouse" periods of the Paleozoic (255 million years ago) and Mesozoic (55 million years ago) eras.

"We didn't even know what we were going to find," Breecker says.

In fact, the team of researchers concluded that atmospheric carbon dioxide levels during the ancient greenhouse events were quite similar to projected climate-change scenarios for the year 2100, meaning we could be a lot closer to a hotter planet than we thought.

"It actually looks like the CO_2 concentrations during the hothouse in the Mezozoic—the greenhouse climates—may not have been much higher than where we may be at the end of this century," Breecker says.

Past studies have missed this association, partly because scientists assumed the carbonates' CO_2 levels represent a mean, or average, reading of conditions. But by studying modern soils, Breecker discovered that carbonates form during very hot and dry times when carbon dioxide concentrations are lower than during less extreme periods.

"The carbonates record this kind of anomalous time of year," Breecker says, "and because they form during the extreme conditions, the atmospheric CO_2 concentrations that you calculate are actually lower than they otherwise would be."

The results, which were published in the *Proceedings of the National Academy of Sciences* in December 2009, supersede preceding reports on prehistoric CO_2 levels. Previous studies suggested past greenhouse events occurred when atmospheric carbon dioxide reached 3,000 to

4,000 parts per million. Breecker's findings update the greenhouse estimates to just 1,000 parts per million.

The data also correlates with levels detected from other proxies that preserve pieces of the geologic record. Scientists have studied fossil plants and leaves and other proxies and discovered evidence of the lower CO_2 levels during greenhouse periods, but most geoscientists were unable to square those measurements with the previous observations taken from the ancient soils, or paleosols. Breecker's work resolves the discrepancy.

"The concentrations we got from the paleosol carbonates are in better agreement with other proxies," Breecker says. He adds that newer numerical models also support the findings.

The insight into the past is essential to our understanding of geologic processes in ancient eras. But Breecker also emphasizes the critical importance of the implications for the future and how we prepare for and continue to monitor climate change during the next century.

"I think that geologists who are doing most of this work are always excited about looking into the past," Breecker says, "and I think there is a tendency to not spend quite enough time on the modern environments and to know what your proxies mean before you go ahead and collect some ancient samples that are going to tell you something about the past.

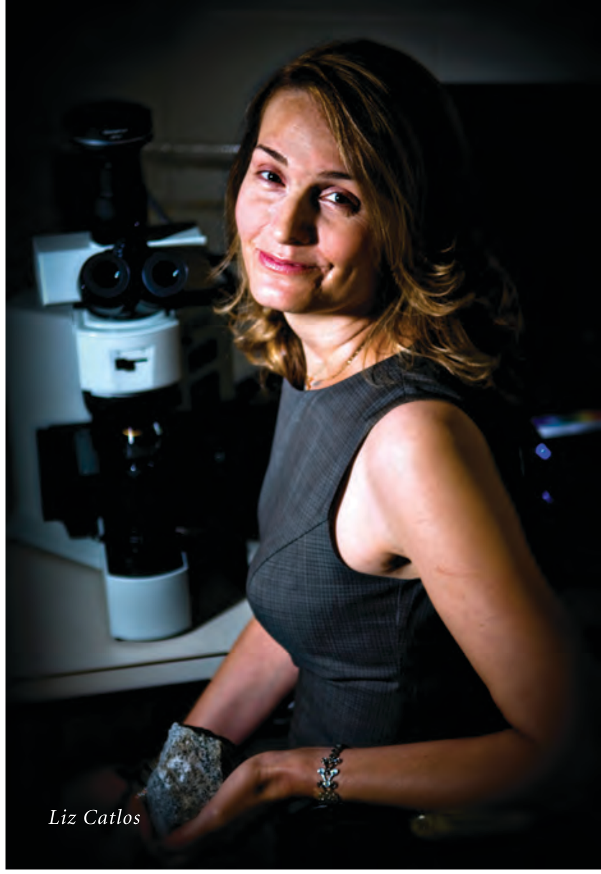
"The main motivation I use for my research," he continues, "is to try to better understand and better predict climate change by calibrating these proxies and figuring out what they mean for past climates, so we can better understand the future."

Breecker plans to continue examining past and present soils and CO_2 levels. Along a related track, he is working with Jackson School colleague Jay Banner to study the formation of calcium carbonates in caves, which provide another measurement of ancient climate levels and their relation to modern conditions.

Breecker is also launching research on the Marais des Cygnes National Wildlife Refuge in Kansas, studying how soils of the native prairie sequester, or trap, carbon. Land managers have conventionally encouraged forestation, rather than prairie restoration, as a means to store carbon and offset human CO_2 emissions. But Breecker has made initial observations suggesting that native grasslands store a much greater amount of carbon and organic matter than farmlands, and he believes further measurements could influence management strategies to store carbon and restore native prairies.

"I definitely think there's work to be done here," Breecker says, "and I think part of the reason is that everyone's so focused on the past rather than what's happening in the present." ✷

– Joshua Zaffos



Liz Catlos

Top of the World

LIZ CATLOS FINDS HER HOME IN THE FIELD

Most of us learned in school that the Himalayan mountains were formed over millions of years as India plowed into Asia. As the two continued to pile into each other, the land in between crumpled, forming a landscape that makes mountaineers salivate. Geologists figured that as the crumpling progressed, a succession of faults opened up to accommodate the deformation, starting first in the north and then progressing one after the other as old ones froze up and new ones sprang into motion to the south.

As a graduate student at University of California, Los Angeles (UCLA) in the late 1990s, Catlos collected samples of garnet-bearing rock along the oldest, most northerly of these faults, the Main Central Thrust, which snakes 1500 miles across the Himalayas. Garnets record information about pressures and temperatures they experienced when they crystallized, as well as when they formed.

Back in the lab, Catlos sliced up the garnets. Using an instrument called an ion microprobe, she was surprised to find that the rocks were deep underground until very recently. Some had experienced temperatures of 500 degrees Celsius just a million years ago, a blink in geologic time. That translates to a rise of about 20 millimeters a year if everything was continuous.

"So it's basically like an elevator," she says. "Those rocks are coming up fast, fast, fast in geologic time."

It also meant the fault is still active. Conventional wisdom suggested that this fault ground to a halt 20 million years ago.

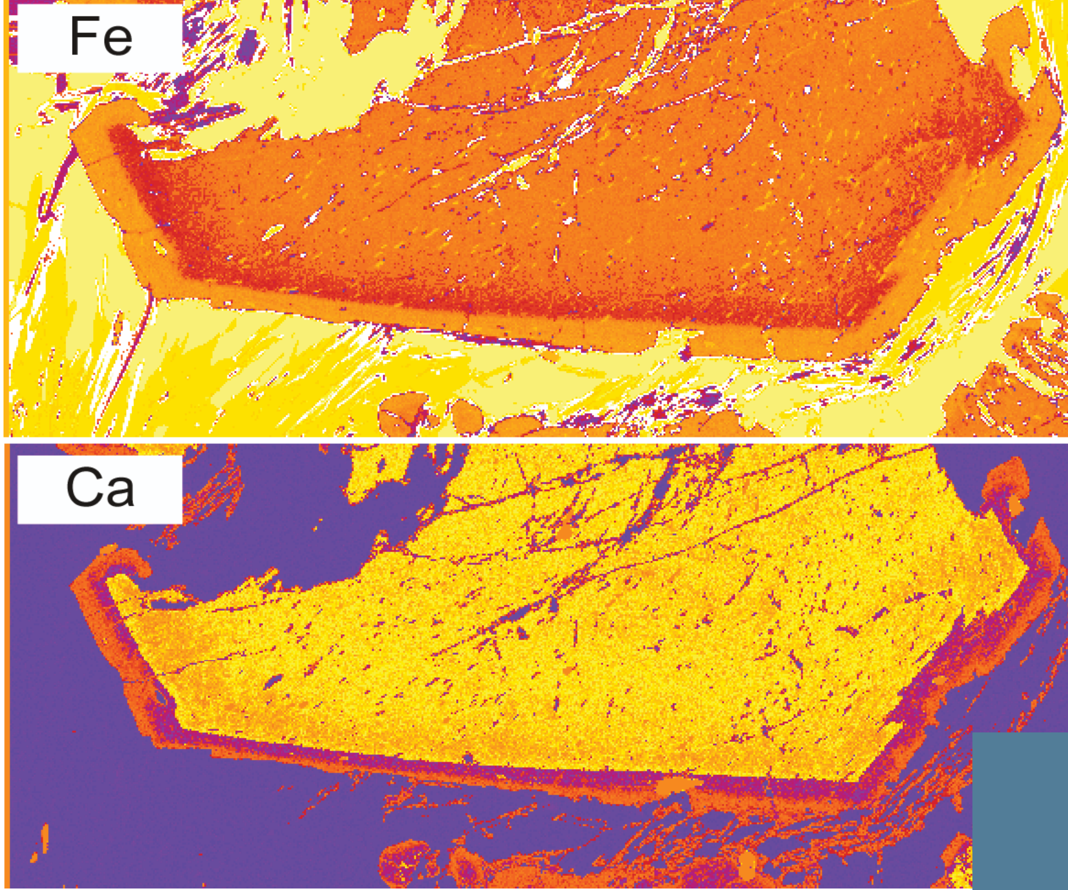
"So the models for the Himalayas had to be rewritten," she says. "There are still some people who like to hold on to those ideas. But we're not the only people who have found it now."

Snowmelt from the Himalayas flowing south in countless rivers nourishes millions of people in northern India through a system of dams. Some of those rivers cross the Main Central Thrust.

"If you think the fault is no longer active, your geologic models will tell you that building a dam in the area is just fine," she says. "That's a problem."

Advisors to the Indian government are currently developing a seismic hazard map for the capital New Delhi, a megacity a few hundred miles from the Himalayas. Spurred by Catlos' insight, they are now trying to determine what the possible shaking might be in New Delhi from a Himalayan earthquake.

For her discovery, she received the Geological Society of America's 2006 Donath Medal, awarded to a young scientist for outstanding research that marks a major advance in the earth sciences.



A thin slice of garnet from the Main Central Thrust in the Himalayas is flooded with x-rays to reveal the distribution of iron (top) and calcium (bottom). Purple reflects low concentrations, orange is medium, and yellow is high. The edge of garnet changes in composition dramatically, indicating it did not grow continuously, but experienced a change in chemistry likely driven by movement within the fault.

From Chemist to Field Geologist

When Catlos began her college career at the University of California San Diego, she planned to become a laboratory chemist, but ended up a field geologist.

The transformation started when she took a class co-taught by Jeff Bada, a geochemist who studies amino acids delivered to Earth by asteroid and comet impacts, traces of which are found in Greenland ice cores.

"He came in and dazzled the class," she recalls. "He challenged us to think about big questions like, What is the origin of the earth? How do mountains form? How can we get at that by using chemistry? And that was very interesting to me."

She realized she didn't have to spend her career stuck in a lab, she could actually make a living doing field work. She could go out and collect her own samples and apply chemistry to real world problems. Bada invited her to do an internship with him working on his Greenland ice cores.

Later, she set off to graduate school at UCLA with a plan to develop a new technique for dating minerals, but that wasn't going so well. One day, her advisor, Mark Harrison opened up a cabinet in the hallway outside his office with 76 hand-sized rocks he'd collected in the Himalayas and said, "This is your new project. Welcome to field geology."

"Those Himalayan rocks are the foundation," says Catlos. "I still use the same techniques I used as a graduate student, but apply them to different places and different rock types."

She was soon off to Nepal for her first major field trip. It seemed like everything that could go wrong went wrong. While on their way to India, her advisor's family's passports were stolen. They were locked up in Indira Gandhi International Airport until their status could be cleared up. After arriving in Nepal, their flights into the field kept getting canceled, so they finally had to rent a helicopter.

"The first trip to Nepal helped teach me the importance of planning," she says, "having a plan B, knowing how to manage when things go wrong, understanding the culture, being aware, being street smart in a street that is not in the U.S."

She's taken many more field trips since then and she finds she learns something new that helps make the next trip more successful. The next year, she spent the entire summer in a tent on the Tibetan Plateau.

"I thought I don't need any tent stakes, my luggage will hold the tent down," she laughs. "And then these winds came through. I got rolled in my tent."

As a field assistant working for another graduate student, she used a kite to take aerial photos and map the field area and she identified minerals. She got the job because the field assistant from the previous summer told his advisors he got a vaccination in the arm that gave him arthritis.

She ate lots of instant noodles, Power Bars, and dried flat bread. Occasionally they could buy meat in the countryside or locals would offer them food.

"There were a lot of challenges," she says, "just like any international project: different food, environment, culture, weather, long drives, crazy traffic, sickness, personality conflicts, but I realized that I really enjoyed geology. I loved it."

"If I hadn't felt so passionately for it and got so excited about what we saw every day, it would have been miserable," she adds. "So, that trip and the Himalayan trips, which were also challenging, reinforced that this career is the one for me."

Over the next few summers, she did field work in northern and southern India, the Himalayas, Slovakia and Western Turkey.

Years after her first trip to the Tibetan Plateau, she was at a scientific conference and ran into the former grad student who had bowed out and given her the chance to go. He confessed that he really didn't have a bad reaction to a shot. He just didn't want to go.

A New Home in Texas

Catlos was an associate professor at Oklahoma State University for one year when she received a Harrington Fellowship to take a year leave of absence to do research at The University of Texas at Austin. During her fellowship, she also organized an international conference on the geology of the Aegean.

In 2008, she joined the Jackson School as an associate professor. Her first academic year on faculty was spent overseas, teaching at the Middle East Technical University in Turkey on a Fulbright Lectureship. She had already become interested in the North Anatolian Fault, a major strike slip fault with many similarities to the San Andreas she new well from growing up in California. The fellowship gave her a chance to meet Turkish researchers and learn more about the geology of the region.

"It's a great place for geology," she says. "Exposures of all rock types, all different types of faults. Two oceans have disappeared in Turkey, so the geology is fabulous."

For the past year, she's been back teaching and doing research in Austin. In spring 2011, she'll teach a graduate course on the geology of the middle east.

"It's going to cover everything from the origin of petroleum deposits to basic tectonics to volcanism to interesting environmental geology," she says. "So it's going to be a reader of new and exciting topics coming out of the Middle East."

Topics will include the environmental impacts of recent wars in the Persian Gulf and the debate over the nature of the plate boundary between Cyprus and Israel. Her choice of topics reflects a mind constantly searching for solutions to geological puzzles.

"What is it?," she asks. "Strike slip? Compression? Extension? It's not been conclusively identified and it's so bizarre that we're living in this day and age and why don't we know this?" ✳

—Marc Airhart

Marc Hesse

Pore Boy

MARC HESSE RIDES A GROWING WAVE OF CARBON RESEARCH

With Undersecretary of Energy Steven Chu calling for "widespread, affordable deployment" of carbon capture and storage technology within 8 to 10 years, the future looks bright for carbon sequestration researchers. But sequestration will only be viable if scientists can assure the public CO_2 won't leak back to the surface, or worse, into their drinking water and cellars. And that requires a deep understanding of where the CO_2 goes and how it interacts with its environment.

Most of what is known about CO_2 trapping mechanisms comes from computer models. Marc Hesse, who has done pioneering work with these kinds of simulations, warns the computer models can only get you so far.

He spent the last two summers at the University of Cambridge running experiments in a physical model of the subsurface and comparing them to simulations. The physical model, developed with colleagues from his days as a graduate student there, is a clear plastic box about the size of a board game box packed with water and clear glass beads. To mimic what happens when CO_2 is injected deep underground, the researchers add a blue fluid designed to act like CO_2.

The researchers determined the rate at which the CO_2 dissolves into water, which is thought to be the main trapping mechanism in many reservoirs. As the CO_2 dissolves into the water its density increases and the CO_2 saturated water begins to sink, forming long fingers. Fresh water rises up to take its place through convection, allowing more CO_2 to dissolve. This convective process has the potential to speed up the rate of dissolution, trapping the CO_2 much more quickly and increasing the storage security.

Early computer models missed these plumes of CO_2 because they're small, perhaps only a meter across once you scale up from

"UT is the largest center for CO_2 storage research in the world," says Hesse.

the tabletop model to the real world. Yet most computer models of the subsurface, to minimize computational demands, carve up the world into three dimensional blocks 10 or 100 meters to a side, far too large to capture these features. That means CO_2 may dissolve into the water much faster than predicted by computer models, significantly reducing the distance it travels.

"It's dangerous because one should never trust numerical simulations that have not been benchmarked against experiments with similar dynamics," he says. "There is almost no data in the literature that allows quantitative comparison, in other words, one that goes beyond 'Well it looks sort of the same.' We are producing that data, and the theory that is necessary to draw any general conclusions from it."

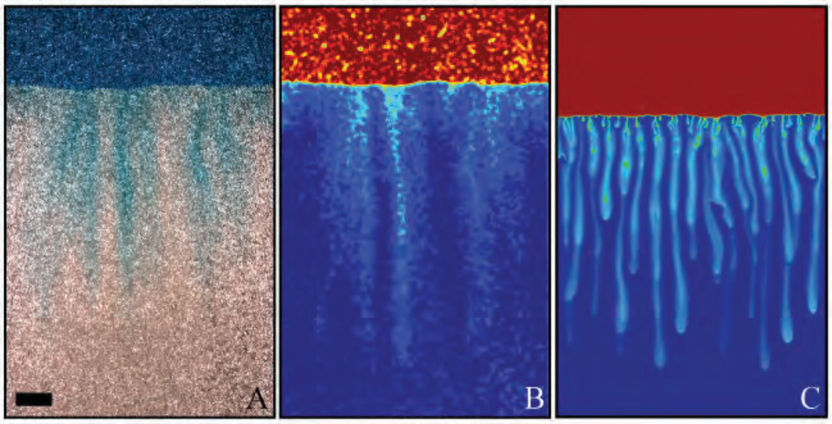
Hesse plans to harness the computational infrastructure of The University of Texas at Austin's Center for Computational Geosciences & Optimization and the Texas Advanced Computing Center to resolve the small scale convective currents and allow more accurate predictions of the long-term migration of injected CO_2.

Downhill Run

Hesse grew up in Germany near the Alps.

"I guess being close to the Alps subliminally influenced my decision to become a geologist," he says. "I enjoy skiing, snowboarding, sleds, telemarks, and anything else that slides downhill."

Like a cross country skier, he zigged and zagged through his education. He sailed from geological engineering—answering questions like, "What size building will this soil support?"—to classical geology—studying things like how rocks form—to flow in porous media—the study of how fluids flow through and interact with rocks in many geological processes. He realized that flow in porous media is a fundamental process with applications across the Earth sciences and that theoretical advances in this field have the potential to solve a wide range of problems.



Water with dissolved CO_2 sinks and forms long fingers clearly visible in (A) a snapshot in visible light from Hesse's physical model, (B) a concentration map based on dye intensity from the physical model, and (C) a computer model. Hesse and his colleagues showed that these fingers predicted by computer models do actually form and that they speed up the rate at which CO_2 dissolves into water.

One such process fundamental to the evolution of Earth is melt migration or magma dynamics, essentially the study of how material deep underground melts, moves to Earth's surface, and changes along the way. Another is carbon sequestration.

He slalomed through a master's degree in oceanography melting rocks in high-pressure lab experiments to study melt migration at mid ocean ridges. He sliced through a second master's modeling fluid dynamics on a computer. He slid to a graceful finale with a Ph.D. at Stanford in petroleum engineering, where he combined theoretical work with numerical models to investigate how far an injected plume of CO_2 would spread before becoming trapped. That work laid the foundation for his recent physical modeling work at Cambridge University. In California, the boy from the mountains learned to ride the waves and became the president of the Stanford Windsurfing club.

In a postdoctoral appointment at Brown University, he revived his interest in melt migration. At UT Austin he is currently pursuing research in both CO_2 storage and in melt migration.

Texas and the Carbon Boom

Hesse came to UT Austin in 2009 in part because of strong carbon sequestration programs in the Bureau of Economic Geology's Gulf Coast Carbon Center, the Department of Petroleum & Geosystems Engineering (PGE), and the Institute for Computational Engineering and Sciences. He works with colleagues and students in all three units.

"UT is the largest center for CO_2 storage research in the world," he says.

Hesse organized a Gordon Research Conference this past July focused on the simulation of geological CO_2 storage.

"The idea is you take the world's top people in a subject area and sequester them in a prep school in Maine for a week," he says. "There are some lectures, but mostly a lot of open discussions. People present cutting edge results and it is understood that what is said at the conference stays there."

This confidentiality promotes a direct and free exchange of ideas. The conferences are designed to stimulate new directions for research by creating a third channel for communication beyond publications and large scientific meetings.

It was all part of a busy summer for Hesse. In addition to the conference and his physical modeling research at Cambridge, he and his fiancé married in Rome.

Things should stay busy for some time to come. Carbon sequestration, a barely existent research area a decade ago, is now undergoing tremendous growth, aided in part by federal stimulus funding through the Department of Energy and increasing interest from the coal and power generation industries.

"You shouldn't let fashions decide your research area," says Hesse. "I chose it because it was an exciting and active field and currently provides the motivation to rethink many old assumptions in porous media flows. Still, it has turned out to be a smart area because of the growth." ✷

Joel Johnson

It's Complicated

JOEL JOHNSON STUDIES COMPLEX FEEDBACKS THAT SHAPE LANDSCAPES

James Bond had his Q. The Jackson School has Joel Johnson. No, he can't supply you with a helicopter in a suitcase or rocket launching cigarettes. He does however have one of the coolest gadgets in the field of sediment transport: smart rocks.

These are cyborg-like rocks that can sense accelerations in all three axes and record them on a memory chip. These accelerations can be used to work out when the rock was moving, how and where it moved, how often it hit the riverbed, and with how much force. Johnson builds them out of real rocks ranging in size from tennis balls to cantaloupes. He slices them open, removes a section from the middle, and glues in a metal compartment. Inside, he mounts a little off-the-shelf black box of electronics that includes a three axis accelerometer and then he screws the whole thing shut.

When non-experts hear the term sediment, they may think of particles the size of sand grains. But to a geologist, these gravel to cobble-sized smart rocks are somewhere in the middle of a broad size scale that ranges from fine clay particles (measured in microns) to large boulders (measured in meters).

The idea of smart rocks has been talked about in the geologic community for at least 20 years, but only recently have the electronic components become compact, affordable, and reliable enough to be practical for field and experimental work. A few years ago, other researchers placed an expensive instrumented boulder prototype in a ravine in the Alps to record the conditions inside a landslide. When a slide finally came, it swept up the rock never to be seen again. It, and the data it collected, lie buried to this day, tantalizingly out of reach.

Johnson hopes to avoid that fate with most of his rocks. He worked with a company to build customized sensors that can collect data for months rather than minutes like his earlier models. He and a student plan to place the upgraded smart rocks in a mountain river in Idaho in early 2011 and wait for a flood. Radio antennas positioned at regular intervals along the shore will help keep track of the rocks via embedded radio frequency identification (RFID) tags. If that system fails, the fallback plan is to wade into the water with a metal detector and locate them based on their metal content. Once they fish the rocks out, they'll open them up and download the accelerometer data.

These data will tell them how high the water flow rate had to be to start moving the rocks and how flow rate relates to the forces rocks feel during transport. By putting out rocks of different sizes, they'll also study how sediment size affects transport. Their ultimate goal is to improve predictions of sediment transport rates (how much mass moves past a point in a given time) and how those rates depend on local water flow rate and river morphology.

He liked the resources available to him, the kinds only a handful of institutions can provide.

"I'm excited about the potential to measure sediment transport from the view of rocks themselves," he says. "It's basically a killer app for people who study mountain river geomorphology."

Oversimplified

Scientists like Johnson who study why landscapes look the way they do, called geomorphologists, often try to distill the processes that create natural landforms—mountain ranges, meandering rivers, deep canyons on Earth and Mars—down into simple but predictive models. Sometimes, says Johnson, they take it just a little too far.

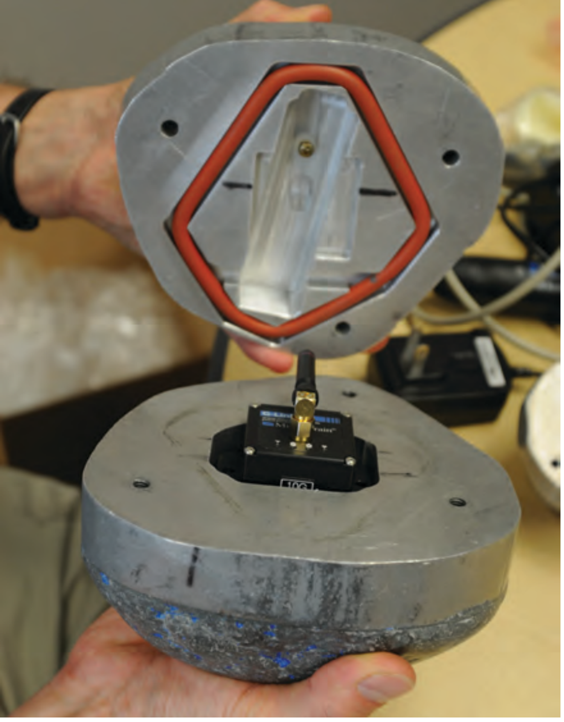
"We all take these complex systems and we say let's cut out this part and let's cut out that part, let's reduce the complexity to something we can understand," he says. "But you have to be careful not to take out the parts that actually make it interesting, and that subtly control system behavior."

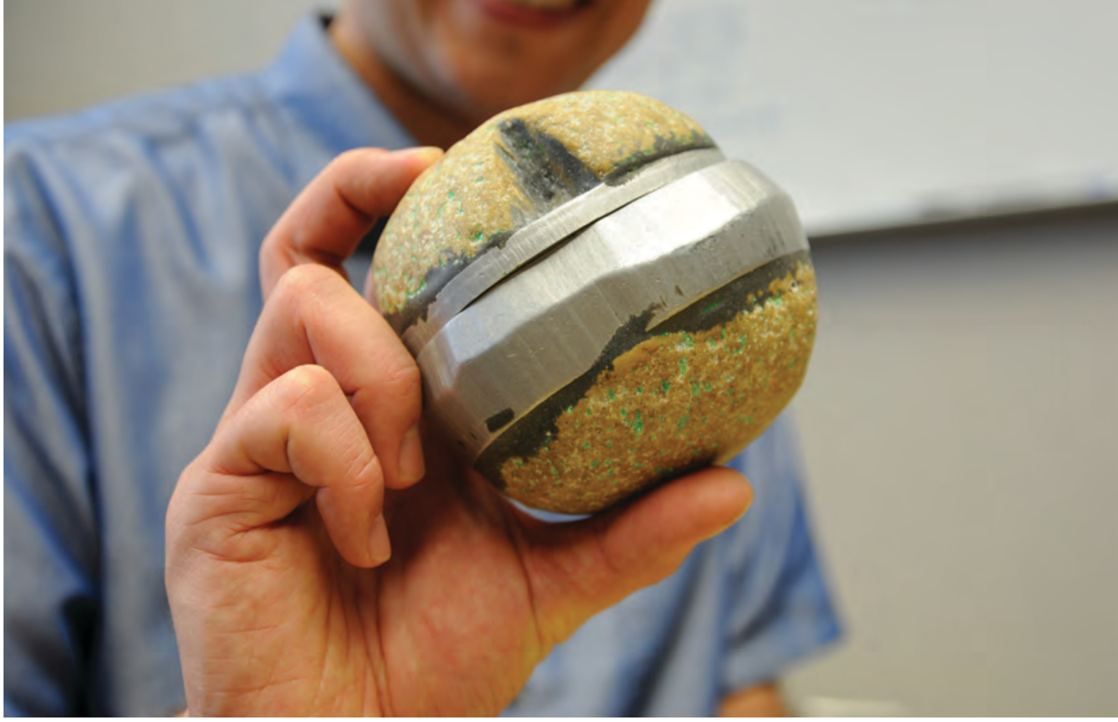
Johnson's approach to complex systems was strongly influenced by David Mohrig, a member of his dissertation committee at MIT.

"You want to embrace the complexity in these systems," says Johnson, "and really try to understand it rather than thinking about it as something that just makes the problem too hard, that you can assume away."

When Johnson was searching for an academic home while completing a postdoctoral fellowship at the U.S. Geological Survey, Mohrig, who had since moved to The University of Texas at Austin, again influenced his thinking. Johnson, who has now completed his first year as assistant professor in the Jackson School, liked the idea of coming back to Texas (he went to junior high school in Lubbock).

He also liked the resources available to him, the kinds only a handful of institutions can provide. For example, he's





Johnson embeds accelerometers inside real rocks to make "smart rocks" that record the motions and forces a typical rock experiences under various stream flow conditions.

remodeling an existing 40 meter flume—a long narrow tank that recreates river flow under controlled conditions—for his own research. And now he's part of a small community of Jackson School researchers developing unique experimental flumes to study surface processes.

"If a place doesn't already have a flume lab, nobody wants to take the space and do the things necessary to build a lab, not for a new junior faculty member," he says. "So I was and still am excited and very appreciative that I was able to show up here and have a hydraulics lab ready and waiting in a sense."

Sweet Spot

Johnson has also started a National Science Foundation funded research project on the big island of Hawaii, to better understand how climate controls landscape evolution.

The Kohala Peninsula, which juts out from the northwest corner of the island, is in some ways the perfect real world experiment. One side is dry, receiving just 25 centimeters (10 inches) of rain each year. The other is wet, getting as much as 4 meters (13 feet) a year. Meanwhile, the dark basaltic bedrock is the same on both sides. Johnson and a colleague are looking to see how the differences in rainfall affect the depths that river channels have carved down into the rock.

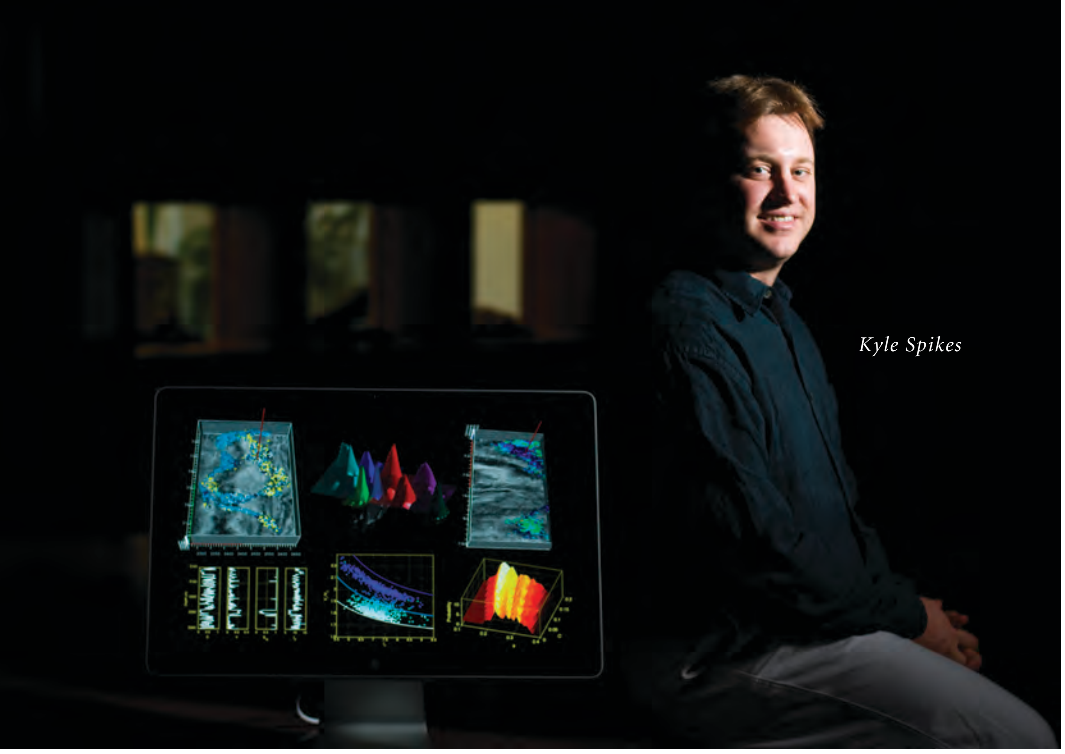
At first, you might assume that the greater the local rainfall rate, the greater the river flow rate, and the greater the river downcutting rate. Flow rate and erosion should go in lockstep, right? But Johnson's preliminary results suggest more complexity. In addition to river discharge, rainfall influences how deeply weathered and physically weakened the bedrock becomes, and also how much sediment washes into river channels. That's because sediment is created as a result of rock weathering and hill slope erosion.

A key goal of the project is to determine which is the most dominant controller of erosion: the sedimentation rate, the bedrock weathering rate, or the actual river flow rate.

If there is too little sediment in a river, the water isn't very effective at scouring away the rocky bottom of the channel. At the other end of the spectrum, if there's too much sediment, the bottom is in a sense insulated from erosion.

"There might be a sweet spot where you get the right amount of sediment coming into your channels and causing more erosion," says Johnson. "In what sounds like a simple system, indeed in all of these geomorphic systems, once you look deeper, there are a lot of feedbacks that cause a lot of complexity." ✷ —*Marc Airhart*

The rainy side of Hawaii's Kohala Peninsula gets as much as 4 meters (13 feet) of rain a year. Johnson is studying how differences in rainfall between the rainy and dry sides of the peninsula affect the depths that river channels carve into the rock.



Kyle Spikes

Computational Horsepower

KYLE SPIKES HARNESSES HIGH-END COMPUTING FOR EXPLORATION GEOPHYSICS

When it comes to heavy-duty computer modeling, there are the Armed Forces, the space program, and then rock physics experts, such as Kyle Spikes.

Spikes, an assistant professor at the Jackson School of Geosciences, studies rock physics ––the exploration of the physical behavior and properties of rocks—using computer resources to analyze seismic data and lab samples. He completed his Ph.D. at Stanford University, which has been at the forefront of the field. After a brief postdoctoral appointment at a university in Norway, he arrived at the Jackson School in 2009, where he uses his background in rock physics to concentrate on exploration geophysics, the study of rock properties beneath the surface to detect conventional and unconventional energy reserves, ore minerals, and other geologic resources.

"My involvement focuses around making computer models of how fractured rocks behave when seismic waves go by and then comparing theoretical predictions to what we see in the real seismic data," Spikes says. "Really what we want to know is how much space is there for fluids to sit in these rocks, what are the rocks made out of, how are they oriented, are they layered, are they homogeneous."

"Teasing out those kinds of properties from seismic data is the world of what we call rock physics," Spikes adds, "and that's where my specialty really lies."

That specialty places Spikes in front of computers most of the time, and his work includes developing computer codes to numerically simulate the seismic data and the behavior of the subsurface rock.

Endeavors in exploration geophysics date back decades, but high-power computation has allowed for major advances in recent years. Today, industry scientists, government researchers, and academics rely heavily on complex models and powerful computers needed to quantitatively analyze and integrate very large datasets.

"Technologically, to put it in perspective, the only people who use more computer resources now are the Department of Defense and NASA," Spikes says. "We've come a long way technologically in 80, 90, 100 years, but to mimic the physics we have to make a lot of assumptions because we simply don't know what's going on at every point in the subsurface. We understand roughly what goes on down there, but it's never a perfect picture."

The challenges are also heightened because exploration geophysics has historically concentrated on oil and gas reserves, but new applied and academic inquiries have branched out to study unconventional resources, such as gas shales, and other pursuits, such as underground carbon sequestration and storage.

"The trick is that we have to venture a little bit away from techniques that people have used in the last 20 to 30 years, where we just take the images from the seismic data and we have some well known models that explain the physics of the rocks," Spikes says. "Now, we're having to make new ones, and having to look for different patterns in the seismic data."

In the case of gas shales, it's very difficult to identify promising locations, and fractures that show up may still be unsuitable to developing a well because of the presence of water or other factors. With underground carbon storage, computer models have to account for where and how fluids move in the subsurface in the presence of carbon dioxide. Currently, government regulations demand very precise measurements, which means Spikes and other scientists must constantly improve their techniques and instrumentation.

"They will no doubt evolve more rapidly in the next ten years than they have in the past, simply out of necessity," Spikes says.

Spikes is looking forward to the coming decades and his contributions to computational modeling and the developments in rock physics and exploration geophysics.

"It's a long-term goal to keep refining these models of the subsurface over and over until we are convinced that they're correct," Spikes says. "By the time that I think I'll be done with all this— which hopefully is a long time— then we should probably be to a point where we're satisfied with the accuracy of the models. I think within my career that should probably happen." ✷

Left: Marathon Oil rig working the Baaken shale. Modeling pore stiffness in the hydrocarbon-rich Baaken formation is one of Spikes' recent areas of research.

Hydrology Field Camp 2010

Scenes from the hydrology field trip to Valles Caldera National Reserve, New Mexico, May 2010.

All photos by Vera Stoyovna.

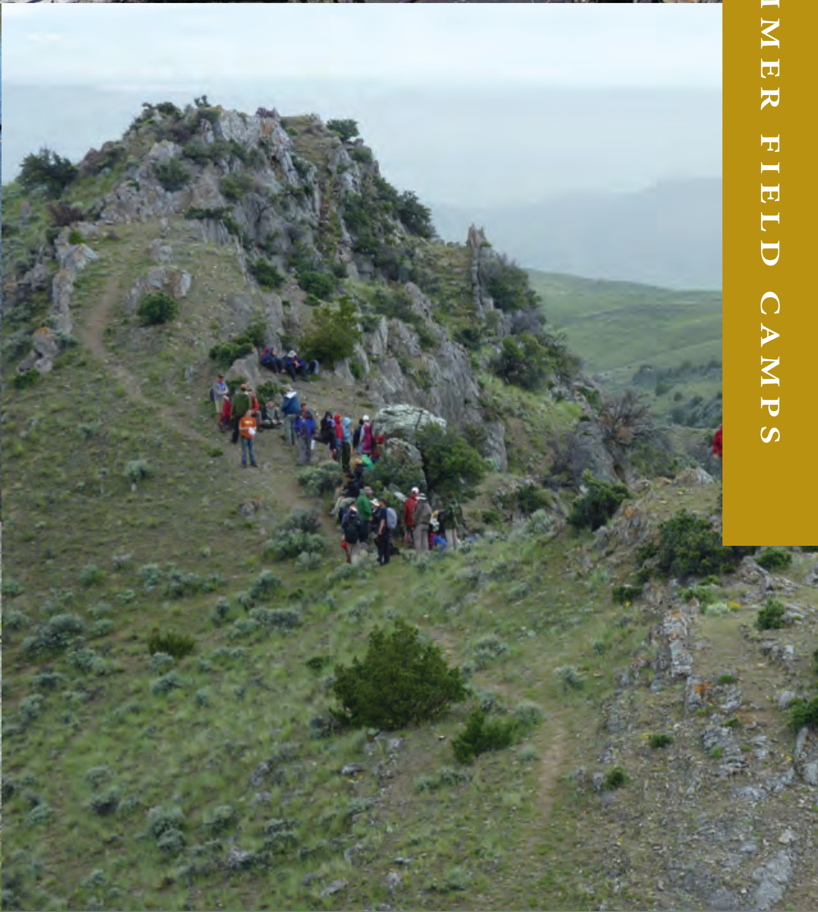
SUMMER FIELD CAMPS

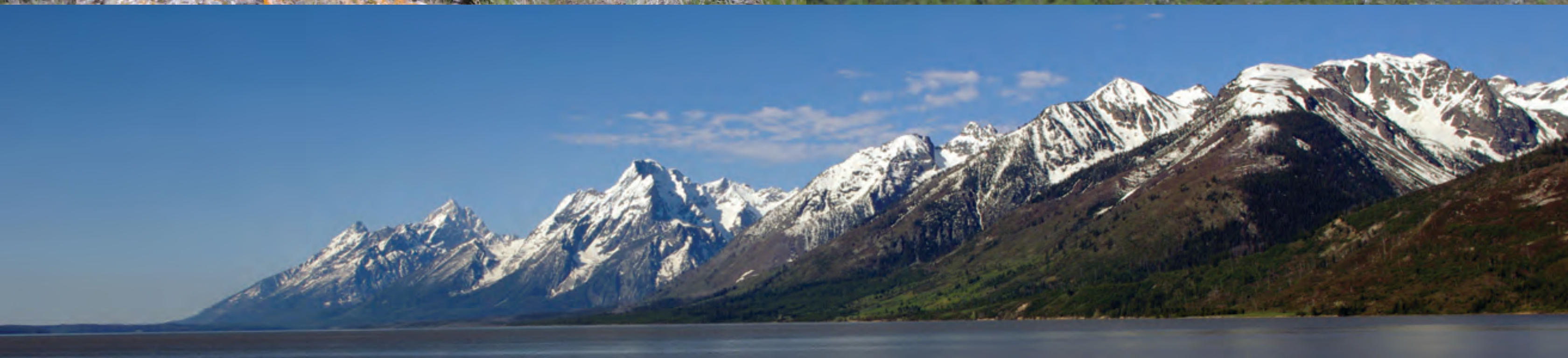
Marine Geosciences & Geophysics / Geo 660

Left page, clockwise from top left: R/V Acadiana; Steffen Saustrup and Sean Gulick prepare the seismic system aboard the R/V Acadiana; The sediement-water interface in a box core; learning how to tie bowline knots.

Right page, clockwise from top left: Mammoth Hot Springs, Yellowstone National Park; tectonic knot; the Grand Tetons; students mapping at Sandy Hollow; fresh catch at Island Park, Bighorn Mountains, Wyoming.

Photos by Marcy Davis, John Goff, Rattanaporn Fongngern, Rocio Bernal Olaya, Jamie Levine, Tip Meckel, Mark Helper.





Rapid Response

UT Austin Geoscientists and Engineers Help Haiti Prepare for Next Big Earthquake

By Marc Airhart

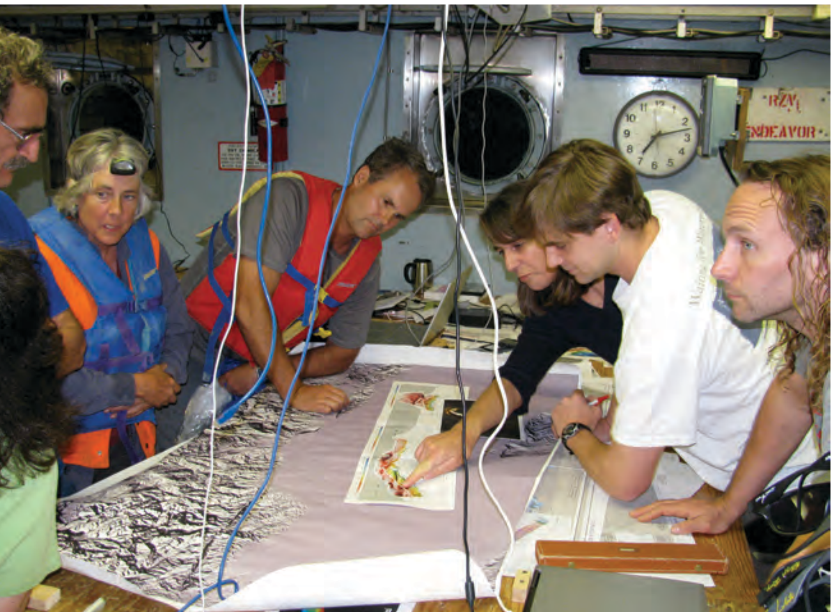
Within weeks of the Jan. 12, 2010 Haiti earthquake, five geoscientists and two engineers from The University of Texas at Austin traveled to the island nation to help assess the damage, identify future earthquake hazards, and make recommendations about how and where to rebuild. They surveyed Haiti from the air, land, coastline, and sea.

The team included Paul Mann, the senior research scientist at the Jackson School's Institute for Geophysics who first identified the large regional strike-slip fault that runs through Haiti's capital, Port-Au-Prince. Mann was prominent among the team of geoscientists who tried, as early as 2008, to warn of the potential for a major, imminent quake in Haiti. (See sidebar, "Warning Signs.")

With the rainy season beginning in late April and hurricane season in July, Mann and his colleagues knew they had to act fast. Storm waves can quickly erase features on the near-coast seafloor related to the quake. Rain can also wipe out features on land such as surface ruptures. For the engineers, it was just as important to assess the integrity of still-standing buildings before people reoccupied them and to make recommendations before the Haitians attempted to rebuild.

When Mann first arrived in Haiti in late January, things were still in a state of "profound chaos." The country was reeling from one of the five deadliest earthquakes in recorded human history. Services for visitors such as hotel rooms, commercial air flights,

Left: The scientific team on board the RV Endeavor included (left to right): Cecilia McHugh (Lamont/Queens College), Leonardo Seeber (LDEO), Carol Prentice (USGS), Paul Mann (UTIG), Milene Cormier (University of Missouri), Matt Hornbach (UTIG), and Sean Gullick (UTIG). Photo: Marcy Davis. Right: Most buildings in the capital city Port-au-Prince were damaged beyond repair during the Jan. 12, 2010 earthquake, which killed 230,000 people. Photo: Wassim Ghannoum.



Opposite page, top: A woman stands in a road filled with debris in Port-au-Prince the day after a 7.0-magnitude earthquake hit Haiti on Jan. 12. Photo: Associated Press Photo/Rodrigo Abd. This page, left: Ellen Rathje, in front of the collapsed presidential palace, studied how physical properties of soil contributed to the destruction. Photo: Wassim Ghannoum. Right: Based on their latest observations, the geoscientists warn that faults in the area are primed for another major earthquake.

rental cars, electricity, and clean drinking water were largely nonexistent. Gunshots punctuated the blacked out nights of the devastated capital as looters ignored the curfew and picked through the rubble of destroyed businesses and homes.

Flying along with a camera crew producing material for the television program NOVA, Mann and his colleague Richard Koehler from Alaska's Division of Geological & Geophysical Surveys were able to survey large areas of the island nation efficiently. With a bird's eye view of more than the geology, they saw homes built on alluvium (loose sediment washed down from deforested areas) that were now piles of rubble. They also saw smaller, hastily built post-quake homes that looked just as unstable as their precursors.

At one point, Mann and Koehler decided to get on the ground for a closer look at the geology. As they approached a flat field for a landing, they noticed throngs of Haitians streaming down mountain trails, some carrying metal bowls, eventually surrounding the helicopter.

"They thought we were with a relief agency," he said. "We didn't speak Creole. It was very awkward."

The magnitude 7 Haiti earthquake killed nearly a quarter of a million people and left over one million homeless, mostly in the capital city of Port-au-Prince. Just over 20 years earlier, the just-as-powerful Loma Prieta earthquake jolted the San Francisco Bay area, killing 63 people and leaving several thousand homeless. Why such a stark difference?

It's now clear that a combination of shoddy building practices and environmental degradation set the stage for the disaster in Haiti. Decades of deforestation and the resulting soil erosion meant much of the soil that people built upon in the capital city was unstable sediment. Add to the mix overcrowding, corruption, and extreme poverty—Haiti is the poorest country in the Western Hemisphere—and the earthquake became a perfect storm.

As part of a National Science Foundation funded rapid response mission, Mann and his colleagues found evidence that the soils were shaken so violently they behaved like a liquid flowing across the landscape, a phenomenon known as lateral spreading and liquefaction. Earthquakes most likely caused by the same fault and resulting in the same soil motion destroyed Kingston, the capital of nearby Jamaica, in 1692 and again in 1907.

Mann and colleagues made a presentation in March 2008 to show enough stress had accumulated on the fault near Port-au-Prince and a parallel fault to the north to generate a magnitude 7.2 earthquake at any time.

Finding Fault

In February, Sean Gulick co-led a sea-based expedition examining the underwater effects of the quake along with Marcy Davis and Matt Hornbach from the Institute for Geophysics, and colleagues from Lamont-Doherty Earth Observatory and the University of Missouri.

For two weeks, the team onboard the 185-foot *RV Endeavor* used sonar to map shifted sediments on the seafloor and seismic sensors to examine faults beneath. Funding was provided by the National Science Foundation and the Jackson School of Geosciences.

As seismologists often observe, in some places where two or more of Earth's plates collide, the rock compresses, stress builds up, and rocks can eventually snap, triggering an earthquake. That's exactly what scientists suspected happened along part of the Enriquillo-Plantain Garden Fault (EPGF) on Jan. 12.

The *Endeavor* team mapped the EPGF as it went offshore near the capital of Haiti, discovering a portion that broke in the earthquake as well as portions that didn't. When one part of a fault breaks, it transfers more stress to surrounding parts. Gulick, a research scientist at the Institute for Geophysics, noted that there are three nearby segments of fault that could be primed for another quake.

"There are at least three different ways this earthquake could trigger a subsequent quake: an earthquake farther west along

"They thought we were with a relief agency," said Paul Mann. "We didn't speak Creole. It was very awkward." Photo: Paul Mann.

Enriquillo-Plantain Garden Fault, an earthquake on the same fault to the east, again affecting Port-au-Prince, or even triggering an event on a neighboring fault, " he said.

Fred Taylor, senior research scientist at the Institute for Geophysics, and Paul Mann (back in Haiti for a second trip) measured the rise and fall of corals along the coast to infer how the land shifted during the quake.

The scientists now think the geology beneath Haiti is far more complex than previously thought. In a paper submitted for publication to the journal Nature Geosciences, Taylor, Mann, and colleagues combined data from their rapid response expeditions, seismological observations, and measurements from space to show that the earthquake wasn't caused entirely, or even largely, by the EPGF. Rather, most of the motion was on previously unknown shallow faults, with only minor slip along or near the EPGF. The report ominously notes that much more strain is waiting to be released on the EPGF, as possibly another large earthquake.

Red Light, Green Light

Wassim Ghannoum landed at the airport in Port-au-Prince just nine days after the quake as part of a team assessing the safety of still-standing buildings. About 80 percent of Haitian government buildings had collapsed, including the presidential palace. Vast numbers of government workers died. The president was running the country from a tent at the end of the runway at the capital's airport. The United Nations (UN), which had helped run the impoverished nation before the quake, lost 200 people when one of its main buildings collapsed. Police stations, hospitals and schools collapsed too. Over a million survivors were homeless, living in makeshift tents made of bed sheets.

He said it reminded him of Beirut after the Lebanese civil war. "I just focused on my job, did what I had to do—get in, get out," said Ghannoum, assistant professor in the university's Cockrell School of Engineering.

The 10 person team, organized by the Multidisciplinary Center for Earthquake Engineering Research (MCEER) at the State University of New York at Buffalo at the request of the UN, broke up into smaller units and spent a week visually inspecting 120 buildings. They focused on critical infrastructure such as hospitals, warehouses, orphanages, UN buildings, and government buildings. Buildings that were safe to continue using, they marked green; those that were partially safe, but needed work, they marked yellow; and unsafe ones were marked red. Ghannoum said in some areas of the capital, a third of the buildings were pancaked and another third were "hanging precariously." Of the remaining third that were salvageable, most needed repairs.

"Our mission was to find green buildings," he said. "The more we found, the more they could use." The team made an important first step, but it would take follow-on crews several more months to complete the inspections.

Rebuilding Safely

Ellen Rathje, a professor in the Cockrell School of Engineering, was part of yet another land-based rapid response team sponsored by the National Science Foundation and organized by the Geo-Engineering Extreme Events Reconnaissance Association (GEER), an organization that documents how soils respond to earthquakes, hurricanes, and other extreme events.

"We look at soil as an engineering material," she said, "and are interested in how soil conditions influence damage patterns across an affected area. Soil can increase damage levels by enhancing the levels of shaking or by failing catastrophically through soil liquefaction."

The information they collect helps inform seismic design practices and site location. She acknowledged the earthquake hazard in Haiti can never be reduced to zero deaths.

"There are so many things that we can do that are relatively easy to implement that could have changed this earthquake from a 200,000 death earthquake to a 2,000 death earthquake," she said. "The technical community in the U.S. is asking whether we should be spending all of our time working hard so that the next big one in San Francisco kills 50 people instead of 80, or whether we should focus our efforts so we help these communities dramatically lower their vulnerability?"

She said from an engineering standpoint the solutions are straightforward, but Haitians will have a hard time rebuilding safely because of poverty, corruption, poor understanding of the science of earthquakes, and a lack of engineering standards.

When the earthquake struck, there was a cloud of white dust from all of the collapsing concrete, the primary building material in Haiti. It was common for people to use dirty sand dug out of creeks, mixed with too much water and too little concrete mix.

"This stuff crumbles in your hand," said Mann. "And what they call rebar isn't what we think of as rebar in the U.S. It flexes too eas-

Warning Signs: Caribbean Tectonics

When Paul Mann first started doing geological field work in the Caribbean as a doctoral student in the 1970s, the scientific consensus was that there were few if any active faults in the area. From a scientific standpoint, the study of active faults and earthquakes in the Caribbean was a research backwater.

The 1976 Guatemala earthquake, which killed 22,000 Guatemalans and left a quarter of the country's population homeless, was a warning bell of the deadly potential of faults in the Caribbean. Most geologists at the time had not even recognized that the fault that caused the earthquake, part of the plate boundary between the North American and Caribbean plates, was active.

Mann's advisor had received a grant to study the geology of eastern Jamaica that included a large and very prominent strike-slip fault (in which two tectonic plates slide past each other horizontally) called the Plantain Garden fault. Mann's dissertation-related study led to the idea that the mountainous island of Jamaica emerged about 10 million years ago as a result of sliding along this fault.

Mann also discovered the Plantain Garden fault was the western end of a much longer active strike-slip fault running through the Jamaica Passage, continuing through southern Haiti and the Dominican Republic, and was likely the source of infrequent large earthquakes that had plagued all three countries for centuries. In his 1983 Ph.D. dissertation he dubbed the newly mapped 900 kilometer (560 mile) long seismogenic fault the "Enriquillo-Plantain Garden fault zone" (EPGF) after the fault forming its eastern end point in the Dominican Republic and the fault forming the western end point in Jamaica.

"Some colleagues never forgave me for christening the fault with that long, unwieldy name but just writing out the odd English-Spanish name makes the point that it's a large fault of regional significance."

As a researcher at The University of Texas at Austin in the 1990s, Mann and his colleague Carol Prentice from the U.S. Geological Survey wrote grant proposals to study the stress accumulated on the EPGF and forecast the potential for earthquakes, but the work was not funded and few other scientists were interested in studying the fault, which some continued to doubt was continuous or active.

"All of that skepticism changed suddenly with the Jan. 12, 2010, Haiti earthquake," said Mann. "Suddenly, everyone wanted to learn more about this obscure fault with the long compound name and how it had dealt Haiti such a devastating blow after remaining quiescent for centuries."

Before the quake, average Haitians had no idea the fault was an earthquake hazard.

"It's hard for people to appreciate the danger when the repeat time is so much longer than a human lifetime," said Mann. "Most people living in Haiti had never experienced a large and destructive earthquake."

Some politicians and leaders in Haiti were amazed to hear their country was located in a dangerous seismic area with a history of large earthquakes dating back to the 18th century. Consequently, the government had no disaster plan in place. For three days following the earthquake the government remained in a state of profound shock and was unable to respond to the disaster.

"As scientists we cannot live in an ivory tower," said Mann, "since many lives depend on the information we possess."

Mann and his colleagues made a presentation at a geological conference in the Dominican Republic in March 2008, that used recently acquired GPS data to show that enough stress had accumulated on the EPGF near Port-au-Prince and a parallel fault to the north called the Septentrional Fault to generate a magnitude 7.2 earthquake at any time. They weren't able to predict when such a quake would happen, only that the potential was there.

Eric Calais, Mann's colleague at Purdue University, met with Haitian government officials to try to impress upon them the potential for large earthquakes along the EPGF. But that same year, two hurricanes ravaged Haiti in rapid succession and the government focused its limited resources on responding to those crises.

"It's rare in the earth sciences that you can find, describe and name a 900 kilometer long fault, then witness a large earthquake produced by that same fault three decades later," said Mann. "My biggest regret is not being able to communicate more effectively our message about its potential seismic hazards to policy makers."

The best he can do, said Mann, is to continue to organize meetings and present his scientific results on potentially dangerous faults to policy makers, as they did in March of this year at the University of Miami and in July in the Dominican Republic.

"As scientists we cannot live in an ivory tower since many people's lives depend on the information we possess," said Mann.

The Enriquillo-Plantain Garden fault zone, named by Paul Mann in 1983, forms part of the boundary between the North American and Caribbean plates. The image shows the topography and bathymetry around Haiti, the present-day plate boundaries (red lines), and the epicenter of the Jan. 12, 2010 Haiti earthquake (red star). (Image compiled by Lisa Gahagan (UTIG) with topo/bathy data from Walter Smith and David Sandwell, plate boundary data from the PLATES Project at UTIG, and epicenter data from USGS.)

ily. It's smooth so it doesn't bond to the concrete."

Rebar, or reinforcing bar, is a steel rod embedded in concrete to give it added strength. The three scientists who spent significant time on land—Rathje, Ghannoum, and Mann—all recounted seeing Haitians digging through the rubble of collapsed buildings to pull rebar from the crumbling concrete. Rathje said she's worried they'll just straighten it out and reuse it in new buildings with the same poorly mixed concrete.

"Have you ever fiddled with a paper clip where you bend it back and forth?" asks Ghannoum. "It snaps. It no longer has its strength. On the one hand, you understand they're so poor. On the other hand, if they don't do anything better, they're just repeating the same mistakes."

Ghannoum also worries about trying to push new seismic building codes on Haitians that are as rigorous (and expensive) as those used in the U.S. He worries that people will simply choose not to follow the codes because they can't afford to meet them.

"So the question is can we simplify our state-of-the-art code in a way that it still saves lives without sacrificing too much performance?" he wonders. "The Haitian government needs to struggle with that and figure out what they want. They don't have their own design code yet. Personally, I think it's better to have a decent code that people will actually follow than an outstanding code that no one follows."

Capacity Building

Since the last major earthquake struck Haiti 240 years ago, most Haitians were unaware they were at risk. The scientists from The University of Texas at Austin all said it is critical that Haitians develop local expertise in earthquake science and in constructing buildings to withstand quakes. A Haitian government scientist and two local university students participated in the *Endeavor* cruise, learning the latest concepts and technologies in earthquake science.

"We're trying to engage the Haitian science community," said Mann. "They can help us communicate better with Haitian policy makers and people about the geology behind this devastating earthquake and about the risks going forward."

Haitian scientists also accompanied Rathje on her second trip to Haiti. Rathje, who serves on the board of the Earthquake Engineering Research Institute, said their organization is trying to establish a regional chapter in Haiti.

"The idea is to do short courses and training seminars and set up a library so that they have the technical materials and really try to build the education in the country with respect to earthquake and seismic design," she said. "We can't just come in for a week and then leave and expect that to change anything."

Ghannoum is working with two other engineering professors from his rapid response mission to develop an exchange program in which they will go to Haiti for a few weeks each year to teach university classes in structural assessment and seismic design, as well as workshops for the general public. Students from Haiti could also come to the U.S. for more extensive training.

At the end of the day, the engineers said it really doesn't matter when or how the next big earthquake might happen. What matters is that now people realize large earthquakes can happen in Haiti. Haitians rebuilding their homes and businesses, and the aid agencies helping them, should take that threat seriously. ✷

Members of the scientific team on board the RV Endeavor included (left to right): Chris Sorlein (UCSB), Marie-Helene Cormier (University of Missouri), John Diebold (LDEO), Sean Gulick (UTIG), Bob Wilson, Roby Douilly (Univeriste d'Etat de Haiti), Hal Johnson (University of Missouri), Nicole Braudy (student Queens College), Jacob Deming (Hydrographic Consultant), Cecilia McHugh (LDEO), John Templeton (student LDEO), Katie Ryan-Mishkin (student LDEO), Nicole Dieudonne (Haiti Bureau of Mines and Energy), Leonardo Seeber (LDEO), Marcy Davis (UTIG), Steve Smithe (Univeriste d'Etat de Haiti), and Matt Hornbach (UTIG).

Super Models:

In the Hunt for Resources, Researchers Cut Through Salt Beneath the Sea

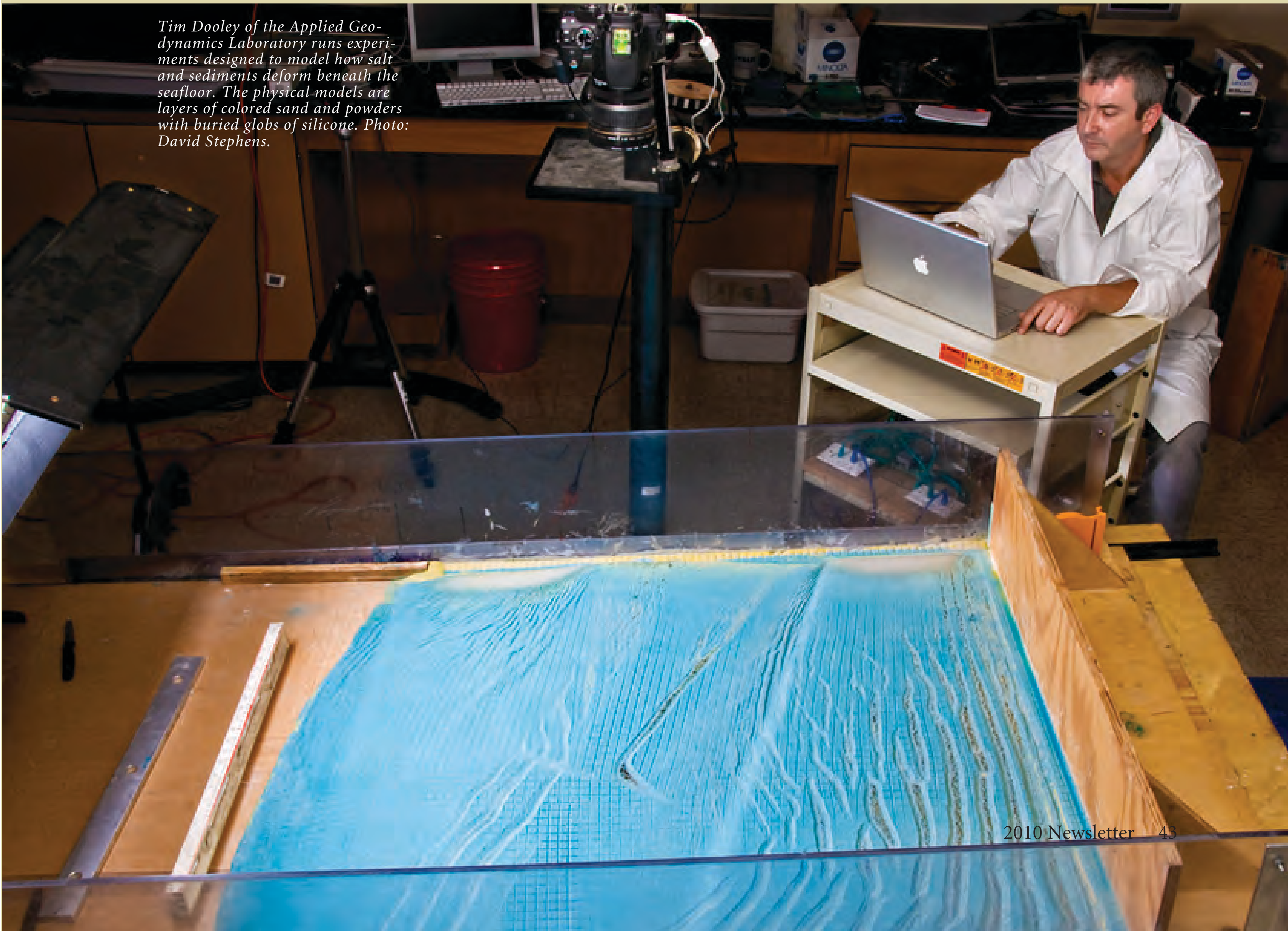
By Marc Airhart

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, and offshore Brazil and West Africa. Petroleum companies are spending billions of dollars in these areas searching for the next giant field.

One of their favorite sources of information, ideas, and research is the Bureau of Economic Geology's Applied Geodynamics Laboratory (AGL).

An oil-industry-funded consortium formed in 1988, the AGL has had a tremendous influence in the field of salt tectonics, the study of the structure and movement of salt. Talks by AGL scientists like Martin Jackson are often standing-room-only affairs at the annual meetings of the American Association of Petroleum Geologists (AAPG). AAPG celebrated Jackson's work with the 2010 Robert R. Berg Award for Outstanding Research, and with his colleagues at AGL he turns out a steady stream of anticipated research papers. Even many of the words scientists and engineers use to describe salt structures—terms like salt canopy, salt weld, and reactive diapir—originated at the AGL.

Much of the AGL's work centers on modeling, which offers great insight into the past, present, and future of salt tectonics and its impact on oil and gas exploration.



Tim Dooley of the Applied Geodynamics Laboratory runs experiments designed to model how salt and sediments deform beneath the seafloor. The physical models are layers of colored sand and powders with buried globs of silicone. Photo: David Stephens.

Models in the Sand

You can tell Tim Dooley is a true scientist because he wears a white lab coat. When he first started doing this kind of work, he'd come home with sand in his clothes and stains from the silicone.

A research scientist at the AGL, Dooley runs tabletop experiments in what look like small sandboxes. Buried inside the sand, globs of silicone gel slowly flow, sometimes in surprising ways. The gel represents bodies of salt the size of mountains oozing beneath the oppressive weight of elephantine piles of sediment in places like the Gulf of Mexico.

After several days, Dooley will cut the blocks of sand open to see how the "salt" has moved and what structures have formed. When the structures start to look like features in the real world, he and his fellow researchers learn about a myriad of factors that shape real-world processes, such as angle of tilt of the underlying seafloor, weight and thickness of the overlying sediments, lateral pressures, initial volume and distribution of salt.

It might seem like an odd past time, until you learn some of the world's most profitable companies eagerly await the results.

In one sense, it's an old fashioned, roll-your-sleeves-up, this-could-get-messy kind of experiment. The basic tools are sheets of plywood and Plexiglas, colored sand, pumps, hand cranks, and a silicone polymer that's one of the ingredients of Silly Putty. When things break down, it doesn't require some million dollar part from the one place in the world that makes it. It takes patience, ingenuity, and maybe a bit of duct tape. You could imagine Benjamin Franklin doing these experiments. (That is if he had any clue that there were salt deposits below the ocean floor.)

And yet, analyzing the results is thoroughly high-tech. Digital cameras automatically snap a shot of the overhead view of the model every 6 minutes. A laser scanner periodically measures the surface topography to within 0.5 millimeters. When the experiment is done, the sand is hardened, sliced up, photographed and reconstructed as a 3D image on the computer in much the same way as a CT scan. Special software allows Dooley to accurately measure internal features in any dimension.

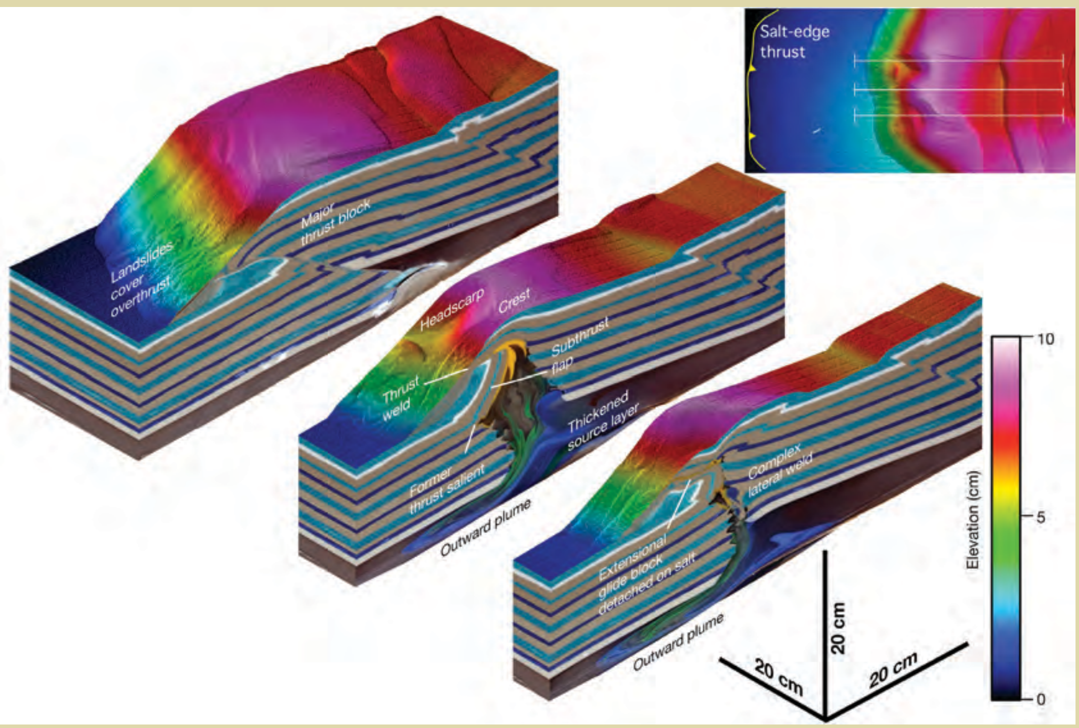
Here Be Monsters

Salt is one of the key factors that make basins like the Gulf of Mexico and offshore Brazil such lucrative places to find hydrocarbons. The basins formed as the movement of tectonic plates stretched Earth's crust. Over millions of years, as the basins were flooded with salt water and evaporated and reflooded countless times, deep layers of salt piled up. There were also loads of sediment deposited above, below, and between salt layers. These basins would have been like big layered cakes, except that as more stuff piled up, the sediments became more compact while the salt didn't. Instead, the salt got squeezed like icing, oozing to the side, sometimes squirting through layers above and spreading out in new areas. The result was something more like a marbled cake.

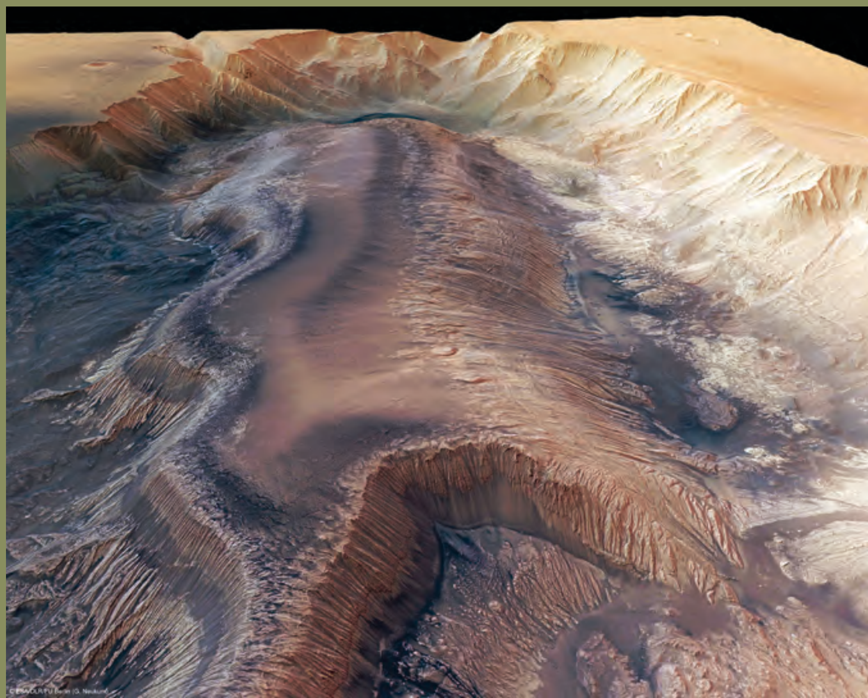
"The movement of salt produces lots of structures in the adjacent sediments that are favorable for trapping oil and gas," says Mike Hudec, a senior research scientist at the AGL.

But there is a downside. For one thing, salt is hard to drill through. It can trap oil and gas at dangerously high pressures. Salt also warps seismic images of areas below it like some stealthy Romulan cloaking device from *Star Trek*. That's because sound waves travel much faster in crystalline salt than denser surrounding sediments, wreaking havoc with seismic data. In the past, oil companies mostly avoided drilling below salt structures. Exploration maps might just as well have read "Here be monsters."

All that began to change in the 1990s as advances in seismic imaging technology helped scientists better understand what these



In this experiment, Dooley squeezed a block of sediment by slowly pushing in one side of the box using a computer-controlled stepper motor. A buried cylinder of silicone (representing a salt diapir) flowed in surprising ways. Marker layers of yellow, green and blue (most visible in the middle cross section) reveal how the diapir deformed and moved. The model revealed a new type of diapir—one in which the cylinder first expands by bulging upward due to lateral compression and then contracts as its contents are squeezed back down, injecting salt back into the underlying source layer. Colors on the upper surface show the topography. Image: Tim Dooley.



Salt Tectonics on Mars

Scientists at the University of Washington were puzzling over Hebes Chasma, a mysterious canoe shaped canyon on Mars that just didn't make sense. Somehow a huge pile of crust, enough to fill the Grand Canyon five times over, vanished. There were no surface outlets suggesting water could have borne it out. The area around the canyon was missing many of the telltale geologic signs that would have implicated tectonic rifting, a cracking of the surface as crust is pulled apart.

Complicating matters further was an enormous dome of rock called Hebes Mensa in the middle of the canyon and as high as the canyon is deep. The mensa seemed to be made out of different stuff than the surrounding walls. Where did that come from?

The researchers suspected heat rising through fractures in the crust melted water ice in the soil and freed water from hydrous salts. As water and dissolved salts drained into a deep aquifer, the surface collapsed.

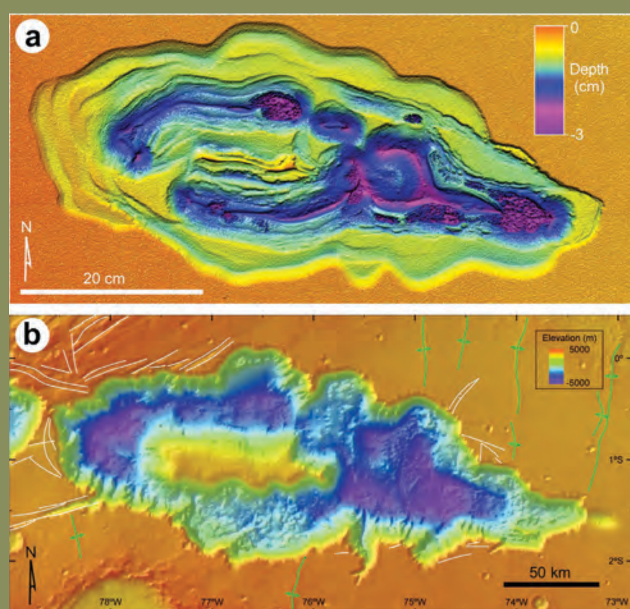
There were signs of high mobility on the canyon floor and mensa, and satellites had detected hydrous salts there. So they also began to suspect that salt tectonics played a role in the subsidence. They invited Martin Jackson to work on the problem with them. He and Tim Dooley designed and ran a series of physical models to test the idea. They cut sinuous slots in the base to simulate subsurface fracture zones. As the models ran, they let sand and silicone drain out. The results were startling.

"We were amazed at how well the models reproduced the landforms of Hebes Chasma," says Jackson. Even a non-expert can look at photos of the surface of the models and the surface of Mars and see the striking similarities. The models reproduced many of the chasma's distinctive features including the central mensa, arc-shaped canyon rims, normal faults along the rims, and closed pits, giving the scientists confidence that the hypothesis is valid.

The models also solved the second part of the mystery. The mensa, it turns out, is a result of columns of salt rising up in the center as overlying material slid off to the sides and down the drains.

Jackson, Dooley, and their University of Washington colleagues published their initial results in the journal *Geology* in August 2009. An extended paper that adds more evidence supporting the hypothesis is in press with the journal *GSA Bulletin*.

Above: Scientists have long wondered about the origin of a deep canyon on Mars called Hebes Chasma and the smooth mountain in its center, known as Hebes Mensa. The canyon is nearly five times larger than Arizona's Grand Canyon. Scientists directing the European Space Agency's Mars Express spacecraft snapped this image in 2005. Image: ESA/ DLR/ FU Berlin (G. Neukum). Below: "We were amazed at how well the models reproduced the landforms of Hebes Chasma," says Martin Jackson. Many of the features of the real canyon (b, credit: Ernst Hauber) are cannily reproduced in the AGL's physical model (a, credit: Tim Dooley).



environments were like. Pioneering physical and numerical modeling work by scientists at the AGL and elsewhere also contributed to a new confidence in working in the salt environment.

Let's Talk Salt Tectonics

In the mid-1980s, Jackson, now a senior research scientist at the AGL, and his colleague Chris Talbot, now a professor emeritus at Uppsala University in Sweden, predicted a new kind of salt feature based on physical models. Then they went out and found one in central Iran. They dubbed it a salt canopy. From above, it looks like a huge lobed dome of salt. Their key insight was that the dome was really more like a forest canopy with trunks and roots made of salt supporting and feeding it. That meant there was 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.

In the old days if drillers struck salt at say, 1 kilometer below the seafloor—now considered shallow in the oil industry—they would assume they had hit the top of a solid underground mountain of salt that extended many more kilometers, right down to the bottom of the basin. There was no point in drilling any further, the reasoning went.

"Some of these canopies are very thin and if you drill past them, you pass into a massive subsalt regime," says Jackson. "Underneath the canopy, you might find subsalt treasure."

And find treasure they did, especially in places like the Gulf of Mexico. Scientists at the AGL have continued to define and redefine the frontier of salt tectonics.

Recently, Hudec and Jackson discovered that the margin of a large salt canopy in the Gulf of Mexico called the Sigsbee Escarpment , previously thought to be stationary, is actually moving slowly away from shore. This movement produces many thrust faults along the leading edge of the canopy as it bulldozes sediment in its path, a concern for exploration geologists who drill new wells through the canopy edge, probing for deeper targets. Chances of any one fault being active today is very small, says Jackson, but the potential for slippage needs to be factored into drilling plans.

Jackson founded the AGL with help from Marcus Milling, former associate director of the Bureau of Economic Geology, and Bill Fisher, its former director. Widely considered the world's premier institute for salt tectonic research, the AGL has received $13.7 million for research from its 30 consortium members since its founding. This has supported physical and numerical modeling, as well as global field work and seismic interpretation.

After more than 20 years, there seems to be no end in sight for the AGL's research. It's a testament to the bewildering complexity of the natural world and the challenges of reproducing that complexity in sand or on a computer. The AGL team is on the eve of publishing a sort of Encyclopedia Galactica covering everything we know about salt tectonics. There's a sense that the day the digital ink dries on The Salt Mine, as the atlas is being dubbed, it will begin to be superseded by the discovery of new salt structures that don't fit any known models and new ideas about how they formed. And that suggests a long, relevant future for the AGL and physical modelers like Tim Dooley.

Playing in the Sand

A Scottish geologist, Sir James Hall, made the first known physical (or analog) model of a geologic system in 1815. By compressing a pile of linen and wool cloths in a box with moveable sides, he recreated the kinds of folds he observed in natural rock layers.

AGL in the Field

The AGL's scientists don't just work in the physical modeling lab or at computers. They have done ground-based studies in the Canadian High Arctic, Paradox Basin in Utah, the Democratic Republic of Congo, the French Pyrenees, the French Alps, and Iran. They have also conducted seismic research in the Gulf of Mexico, Bay of Biscay, and offshore Angola, Gabon, Israel, Lebanon, and Brazil. Farther afield, they have studied features on Mars and Neptune's moon Triton.

The Salt Mine

Before he came to work at the Applied Geodynamics Laboratory (AGL), Mike Hudec worked for Exxon as a representative to the AGL. It was his job to go back and disseminate their research results to the people who needed it within the company, which turned out to be a couple hundred people.

"I sent emails, I held brown bag lunches," he says, "but at the end of the day, people who needed the information still weren't getting it. Our internal technology transfer was poor."

For the past decade, Hudec has worked with Martin Jackson and more recently with Tim Dooley and Nancy Cottington, an illustrator at the Bureau, to compile *The Salt Mine: An Interactive Atlas of Salt Tectonics*. When complete later this year, it will be the most comprehensive collection of salt-tectonic images and animations ever assembled. It will be useful as an introduction for those new to salt tectonics and as a comprehensive source of analogs for experienced users.

"My guideline is that if you can't find the answer in three minutes, the answer may as well not exist," he says. "People are busy and don't have time to do a whole research project for every question they have."

The atlas will be useful to anyone interpreting seismic data of salt structures. When parts of their seismic data are fuzzy, analogs of similar areas can help interpreters fill in the unclear parts. In other cases, an interpreter might know the geometry of a salt structure and sediments around it, but wants to understand how the structure formed and how it might have influenced the location of hydrocarbons.

The atlas contains more than 1400 images of salt structures around the world, including field exposures (outcrop views, geologic maps, aerial photographs, and satellite images), seismic sections, geologic cross sections, conceptual sketches, and animations. In addition, the atlas will showcase hundreds of the best examples from AGL's unique collection of physical and numerical models, including models by former AGL staffers Bruno Vendeville, Dan Schultz-Ela, and Josie Dirkzwager.

Over time, other geologists extended the technique using new materials such as oil, wax, clay, sand, powder, plastics ,and gels to simulate a wider range of rock types and environments in nature.

Tim Dooley came to the AGL in 2003 to help revitalize the physical modeling component of the lab. The original equipment from 1988 was limited and outdated. The AGL's previous physical modeler, Bruno Vendeville, was also returning to France. So it was decided that the equipment would be completely upgraded and they would bring in a new person with fresh ideas. Dooley had previously managed a modeling lab at Royal Holloway, a college of the University of London and a leading center for analog modeling research. Jackson admired their models, which he says were "beautiful and cutting edge."

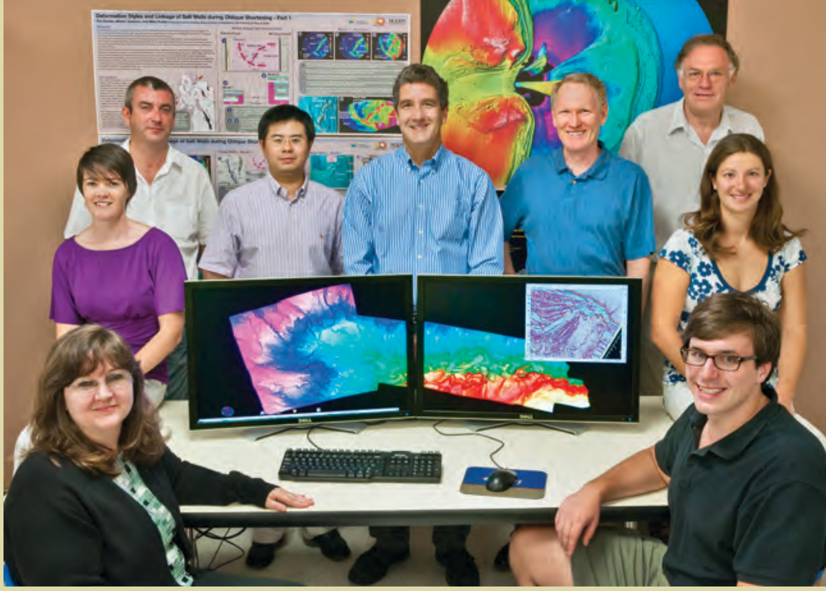
"Tim had many years of experience at a well-known prestigious lab in London," says Jackson. "He was in many respects the ideal person for the job."

Now, every summer, Dooley runs about 20 experiments and spends much of the rest of the year analyzing the results.

Each experiment is slightly different from the one before, depending on the type of system he's modeling. The bottom of the box can be solid or it can be split so that two sections can slide past each other mimicking fault motion. The box can be flat, tilted or tilted in just one section to approximate some unique topography of the basement below sediments. One or more sides can be moved in or out at a constant rate to create lateral compression or extension.

When a model run is complete, anywhere from a day to a few weeks after it began, Dooley pours a gelatin mixture over the whole thing that seeps down into it and firms it up.

Next, he calls in the real muscle—some of the staff downstairs at the Bureau's Core Research Center—to help flip over the several hundred pound block of sand and carry it to a table where it will be sectioned and photographed. It has to be flipped, otherwise, when he cuts slices off, the silicone would ooze out like toothpaste under pressure from surrounding sand.



Formed in 1988, the AGL is widely considered the world's premier institute for salt tectonic research. Researchers and support staff include (clockwise from bottom left): Nancy Cottington, Angela McDonnell, Tim Dooley, Gang Luo, Mike Hudec, Martin Jackson, Ian Norton, Maria Nikolinakou and Mike Braunscheidel. Photo: David Stephens.

The flip requires finesse as well as muscle. In over 165 runs, only two have been dropped during Dooley's tenure.

Then he carefully slices thin sections off the end of the model block with what looks like a fancy cheese slicer, actually a guitar string pulled tight between two metal arms. As each slice comes off, he photographs the newly exposed end, all the way down to the last nub of the 2 meter long block.

Dooley combines a set of 60 to 200 sections into a 3-D virtual model that scientists can "fly through" on a computer much like a CT scan, turning and tilting the block to any perspective and burrowing inside to examine features up close. Dooley says one of the great advantages to this kind of output is that it is accessible to anyone from a seasoned expert right on down to the complete novice.

"It almost sells itself, it's so graphically rich," he says.

At the end of the day, though, he cautions that they're just models. By their very nature they involve many assumptions and simplifications. Their greatest advantage is to stimulate new ideas and then test if an idea makes mechanical sense. ✴

The atlas is designed in HTML, the language of websites, but isn't available on the Internet. Members of the AGL consortium receive it on DVD for use on local computer networks. The public will also be able to purchase a book and DVD published by the Bureau.

Hudec said the atlas will serve as a landmark description of our current understanding of salt tectonics but he doesn't see it as the final word on the subject. Some parts might still be useful decades from now, while others will almost certainly be superseded as technology improves and some concepts are replaced by better ones.

"In science, you don't ever get the final answer, you just try to advance the ball," he says. "That's what we're doing here. The game's never over."

The Salt Mine *includes photos like this one of a salt glacier in a mountain valley, flowing from Kuh-e-Namak, a salt diapir towering 1 km above the adjoining plain in Iran. Photo: Martin Jackson.*

Seawater sprays on the rig floor of the JOIDES Resolution during drilling operations.
Credit: William Crawford, IODP/Texas A&M University.

DOWN TO THE CORE

CRAIG FULTHORPE CO-LEADS RECORD-BREAKING EXPEDITION TO CANTERBURY BASIN BY MARC AIRHART

Craig Fulthorpe was a grad student when his advisor walked into his office and asked if he would like to be part of the first scientific expedition organized by the Ocean Drilling Program (ODP). As luck would have it, a sedimentologist scheduled for the cruise had to back out just weeks before setting sail for the Bahamas and the team needed a replacement fast. Fulthorpe said yes. It changed his career.

"Going on ODP Leg 101 introduced me to this whole community in a way that might not have happened otherwise," he says. "It was a great opportunity. It was my first extended time at sea."

That was in 1985. The ODP was an international partnership that had just begun to explore Earth's history and structure as recorded in the ocean basins. They had recently converted an oil exploration ship into a floating laboratory and renamed it the *JOIDES Resolution*. The first expedition was designed to study the origin and evolution of the Bahamas carbonate platform.

"As a young scientist, it was a great learning experience," he says. "I got to work with more senior people and got real insight into the way large scale science is done."

Today, Fulthorpe is a senior research scientist at the Institute for Geophysics, which itself has a long and storied history with the three major international scientific ocean drilling programs. He works just a few doors down from Jamie Austin, another ocean drilling veteran he met on that first ODP cruise when Austin was co-chief scientist. Fulthorpe came to the Institute early in his career and never left.

This past January, he returned from his fourth cruise through ODP and its successor, the Integrated Ocean Drilling Program (IODP). This time he was co-chief scientist, along with Koichi Hoyanagi from Shinshu University in Japan, on an expedition to Canterbury Basin off the eastern coast of New Zealand's South Island.

DOWN UNDER

Seafloor sediments along continental margins record changes in global sea level going back millions of years. This record has the potential to help scientists forecast how sea level might change as a response to the current period of rapid global warming. Unfortunately, the record isn't so easy to read. Seafloor sediments are also affected by local tectonic, sedimentary, and oceanographic processes. Fulthorpe's cruise to Canterbury Basin was designed to help untangle those confounding effects.

Canterbury Basin is ideal for this work because seafloor sediments there record information about climate and sea level in exquisite detail going back 35 million years. An uplifting mountain chain nearby and strong ocean currents ensure a large quantity of sediment flows into the basin.

Canterbury Basin is one of several sites around the world sampled by IODP scientists to study global sea level changes during Earth's most recent "Icehouse" period (10 to 12 million years ago), when sea level was largely controlled by changes in glaciation at the poles. Data from both the Canterbury Basin expedition and an earlier New Jersey shelf expedition will be integrated to provide a better understanding of global trends in sea level over time.

Drilling in the Canterbury Basin also allowed the scientists to investigate what happened when the seaway between Australia and Antarctica opened up around 30 million years ago, initiating a strong ocean circulation pattern. This major event in Earth's history is recorded in the Marshall Paraconformity, a gap in the rock record indicating an extended period of non-deposition. In core samples, it occurs as a rubble layer between two layers of white limestone.

Fulthorpe says understanding the past helps scientists know what Earth's systems are capable of in the future. For example, scientists studying sediment and ice cores have been surprised to find how rapidly and dramatically Earth's climate can change.

"If you aren't aware that very rapid change can happen, you can't factor it into future predictions," he says. "You have to be aware of everything the Earth can throw at you to address what might happen in the future."

Searching for a previously elusive gap in the core record called the Marshall Paraconformity, the team drilled the deepest hole on a single expedition in the history of scientific ocean drilling (nearly 2 kilometers). Credit William Crawford, IODP/TAMU.

GONE FISHING

The *JOIDES Resolution* is 143 meters (470 feet) long and holds up to 125 people, usually half support crew and half scientists and technicians. The ship operates 24 hours a day with crew members alternating in 12 hour shifts. On a typical two month trip with a full ship, the galley crew stocks 12,000 pounds of fish, 10,000 eggs, 5,000 pounds of fresh fruit and vegetables, 1,000 gallons of milk, and 1,000 pounds of flour.

The ship is operated by the U.S. Implementing Organization, made up of the Consortium for Ocean Leadership, Texas A&M University and Lamont-Doherty Earth Observatory with funding from the National Science Foundation (NSF). The JOIDES part of the name comes from the now defunct Joint Oceanographic Institutions for Deep Earth Sampling.

Fulthorpe says a few things have changed on the *JOIDES Resolution* in 25 years. His first time around, there was no telephone and of course no email. You could write and receive paper letters thanks to occasional helicopter visits from administrators and dignitaries, or establish a phone patch with the help of a ham radio operator, but it was complicated.

"I made one phone call," he says. "It was very awkward. You had people listening in on your end and an operator listening on the other end."

For several weeks at sea, there was little news from the outside world or connection with friends and family far away. It could be isolating, but the upside was that working on the ship in the old days was intensely focused on the job at hand, scientists working seven days a week, pausing for little more than sleeping and eating.

Today, there are satellite phones that let you make calls at the same cost as a call from College Station, Texas, as well as continuous email and Internet access. It's true, says Fulthorpe, you don't feel so isolated. Yet there are a lot more distractions. Your office work and home life follow you around the world. People back home don't understand that you might have a hard time replying to an email within an hour or two.

SMASHING RECORDS

For two months beginning in November 2009, Fulthorpe and his team drilled four sites in the seafloor and recovered sediment cores going back as far as 35 million years. The Marshall Paraconformity

OCEAN DRILLING AND THE INSTITUTE FOR GEOPHYSICS

The history of the Institute for Geophysics is to a large extent the history of the big three scientific ocean drilling programs. Multinational collaborations focused on scientific ocean drilling began with the Deep Sea Drilling Project (DSDP) in 1968. DSDP begat ODP, which begat the current effort, the Integrated Ocean Drilling Program (IODP).

Maurice "Doc" Ewing, one of the most prominent earth scientists of the past century, came to Texas in 1972 to found the research center that would ultimately become the Institute for Geophysics (UTIG). Ewing and his successor at UTIG, J. Lamar Worzel, were co-chief scientists on the first leg of the DSDP in 1968. Arthur Maxwell, UTIG director from 1982 to 1994, made his mark as co-chief scientist of Leg 3 of the DSDP, which confirmed the concept of seafloor spreading, called by some the most significant discovery in the history of scientific ocean drilling.

The close ties have continued to the present, with UTIG researchers conducting pre-drilling seismic surveys, serving as scientists and co-chiefs on expeditions, touring as ODP/IODP distinguished lecturers, and serving in leadership positions with the three programs.

Terry Quinn, current UTIG director, sailed with ODP in 1990 and 1992 and IODP in 2005. The trips focused on using carbonate islands as dipsticks for past sea level. Quinn is currently a member of the IODP Science Advisory Structure Executive Committee, the program's highest advisory group.

"You want the best science to be done by the drilling," he says. "You can either sit on the sidelines and say it's going on or not, or you can get involved. I was raised if you see something that needs doing, get involved."

Jamie Austin, director of the IODP in 1994 and currently a senior research scientist at UTIG, says the relationship between the Institute and the scientific ocean drilling programs is symbiotic. Before scientists drill, they have to have the seismic images to decide where to drill.

"The historic strength of the Institute has been in seismic studies of the sea floor," says Quinn. "NSF knows that if they want it done right, then we're involved. We're one of the handful of places that can do this kind of work."

Likewise, a significant proportion of UTIG's research relies on information from ocean drilling. For example, seismic imaging can reveal the shapes of features in the subsurface.

"To understand how shapes evolved over geological time, you have to tell time," says Austin. "Drilling allows us to tell time by dating sediments and the rocks beneath them."

UNCERTAIN FUTURE

At present, Institute scientists and their colleagues around the world are faced with an uncertain future since the current IODP program, started in 2003, is set to expire in 2013.

turned out to be deeper than initially thought, so they had to ask for permission to drill deeper. They ended up drilling the deepest hole on a single expedition in the history of scientific ocean drilling (nearly 2 kilometers).

When cores are brought up from the seafloor they can be either moist and pliable like tubes of modeling clay or solid cylinders of rock. Once on board, they're sliced in half. One part goes into a refrigerated archive. Team members look over the other half and stick colored flags in it claiming samples for themselves or for shore-based scientists. Some samples they analyze in onboard labs, others they have shipped back to their home institutions for more intensive analysis. Scientific results from their various projects will be published gradually over the next couple of years.

Fulthorpe's main role was to tie the sediments they recovered back to seismic data collected before the expedition. In addition to sedimentologists like Fulthorpe, the team also included experts in paleomagnetics, geochemistry, physical properties of sediments, biostratigraphy, and microbiology. Julie Pollard, a seventh and eight grade science teacher, sailed as the onboard education officer interacting with students around the world through a blog and live video chats.

A second record was broken when the team recovered sediment from the shallowest water site ever drilled for science by the JOIDES Resolution (85 meters water depth). To drill deep holes in the seafloor, the ship uses a Dynamic Positioning System to remain stationary over the hole. A special computer collects positioning information from two GPS receivers and one hydro acoustic beacon on the seafloor to determine real time position and then uses that information to control 12 powerful thrusters and 2 propellers. Maintaining an exact position is especially difficult in shallow water because the distance the ship can safely move off position is a percentage of water depth.

A third record was broken when the team recovered the deepest samples for microbiological analysis collected during scientific ocean drilling (nearly 2 kilometers). These samples could potentially extend the maximum known depth of habitable sediments. The team's lone microbiologist, Maria-Cristina Ciobanu from the European Institute for Marine Studies at the University of Brest, France, is still analyzing these samples.

The team did have some challenges with boreholes collapsing and less than complete recovery of sediments, which is typical of the challenging environment. But Fulthorpe says the expedition went very well from a research perspective. The team achieved all their major scientific objectives, the sediments were not difficult to drill, and the weather was good. He says just as important is what this kind of mission provides to early career scientists.

"It's great for getting them introduced to the community, making contacts, and forming collaborations," he says. "I don't know of any other earth science program as effective in that way." ✷

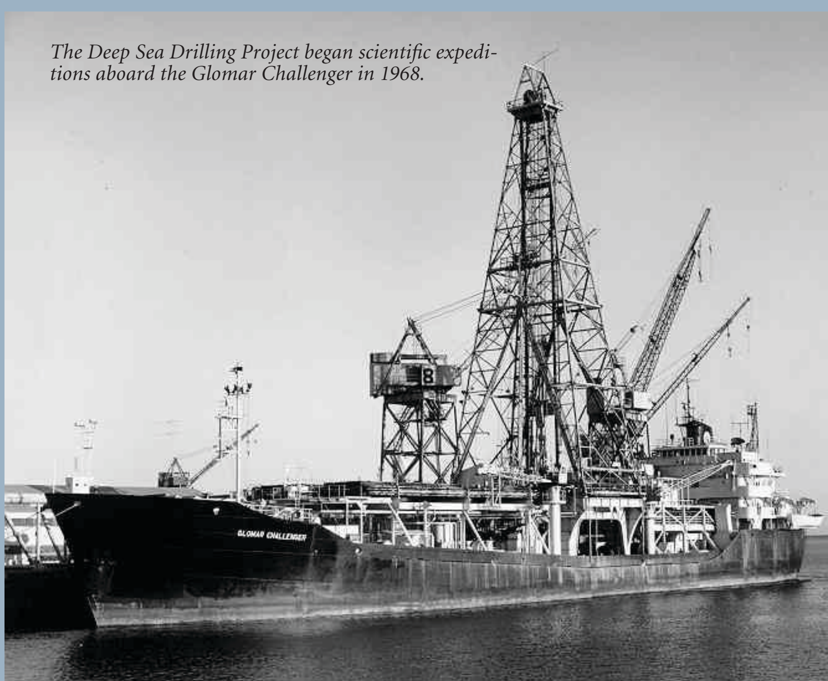
Scientists in the ocean drilling community have produced a report outlining new science that could be achieved with a fourth program and they're beginning to lobby funding agencies like the National Science Foundation (NSF) and Japan's Ministry of Education, Culture, Sports, Science and Technology. But there's no guarantee it will be funded, especially in the current economic environment. And that, worries Austin, would hit the Institute doubly hard.

"We do a lot of seismic imaging and one of the big impetuses to do that would go away," he says. "We'd also lose the drilling. And that will hurt us in trying to understand climate, because you need to tell time to study past climate and you need sediments to tell geologic time."

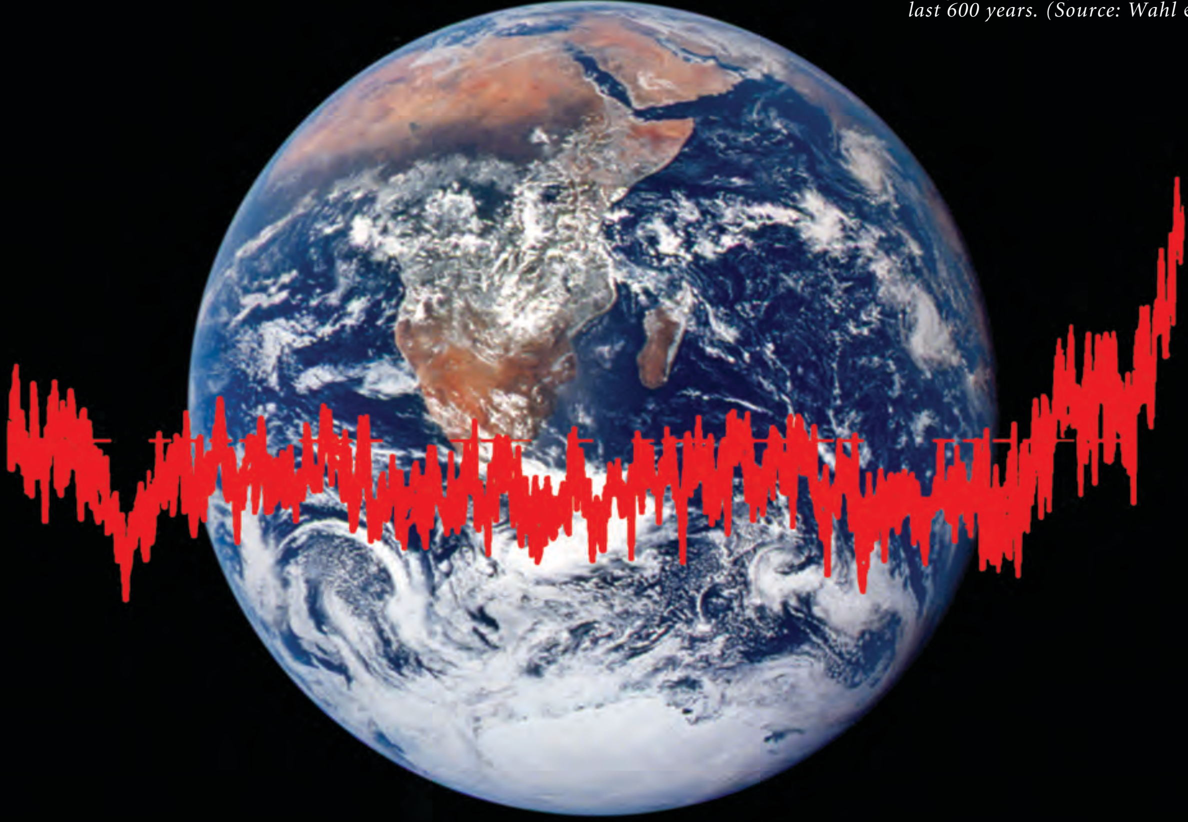
In recent years, scientists have come to recognize that there is a vast world of microbial life beneath the seafloor, perhaps more abundant than life above the seafloor. Writing in the April 13, 2010 edition of the journal *EOS*, UTIG's Nick Hayman and Gail Christeson and several co-authors pointed out that a future drilling program could shed light on this largely unknown part of the biosphere by studying how nutrients, heat, water, and other materials flow through the crust and upper mantle.

Another publication addressing the future of scientific ocean drilling is a sweeping report that grew out of a gathering of over 500 experts from around the world in Bremen, Germany in September 2009. Sean Gulick, research scientist at the Institute and member of the meeting's steering committee, helped compile the report which lays out a set of goals and required technology for a future drilling program. The report identifies key areas where drilling can make a big impact: climate change, the lithospheric membrane (Earth's crust and upper mantle), co-evolution of life and the planet, Earth-human-Earth interactions, extreme events, hominid evolution, and climate-tectonic linkages and feedbacks.

Scientists at UTIG are intently focused on seeing the ocean drilling program continue.



The Deep Sea Drilling Project began scientific expeditions aboard the Glomar Challenger in 1968.



Earth's globally averaged surface temperature since 1400 A.D. shows the planet is hotter and has gotten hotter faster than at any time in the last 600 years. (Source: Wahl & Ammann 2007)

Climate Myths

Jackson School Scientists Set the Record Straight on Eight Persistent Misconceptions

By Marc Airhart

Editor's Note: Part of the mission of the Jackson School, as a leading institution for geoscience education and research, is to communicate school research as it relates to major Earth science issues of the day. In this spirit, this edition of the *Newsletter* offers a look at some common misconceptions about the science of climate change, drawing on expertise from the school's climate systems science group.

This is an article about science, not politics. The distinction is important, since climate change is both a political and scientific issue. At the broadest level, the often volatile political discussions of climate change ask about mitigation: Can and should human beings attempt to mitigate carbon dioxide's effect on the environment? If so, how? Or are such efforts too costly and ineffective to be feasible?

This article is not an attempt to prescribe answers to these policy questions. It is, however, an attempt to set the record straight on some of the science that underlies public discussion of these issues.

There is a need for better science in the public discussion of climate issues. Some of the public figures who challenge prevailing ideas about climate change are well grounded in science, like Roger Pielke Jr., a professor at the University of Colorado at Boulder who writes a popular climate science blog. Others critics are not so well grounded in science. Some recycle ideas flatly contradicted by scientific evidence—for instance, that Earth has been cooling since 1998. As our climate experts explain below, this alleged cooling trend is a myth, unsupported by global temperature records. That fact has not stopped countless bloggers from boldly stating the myth as fact.

Public discussion of climate science is good for science and vital to society. The public is engaging with complex ideas while asking scientists and decision makers to answer hard questions. In the best spirit of science, concepts should be challenged rather than accepted on faith and scientists should be able to prove their claims. It is in that spirit, and with a goal of advancing a better understanding of climate science, that we offer this article. We hope it will begin a dialogue in months to come. Readers are invited to post comments and follow-up questions at our online forum at www.jsg.utexas.edu/climateforum.

Myth 1. What global warming? Earth has actually been cooling since 1998.

Some people skeptical of global warming claim that Earth's global surface temperatures have been falling or have leveled off since 1998. They point to data now several years out of date from U.K. researchers that put 1998 as the warmest year on record. They also point to an unusually cool summer in North America in 2009 followed by an abnormally cold winter across all of the northern hemisphere. People who had to shovel record snows from their driveways or live without power during ferocious snowstorms in the northeastern U.S. began to doubt decades of scientific evidence on global warming.

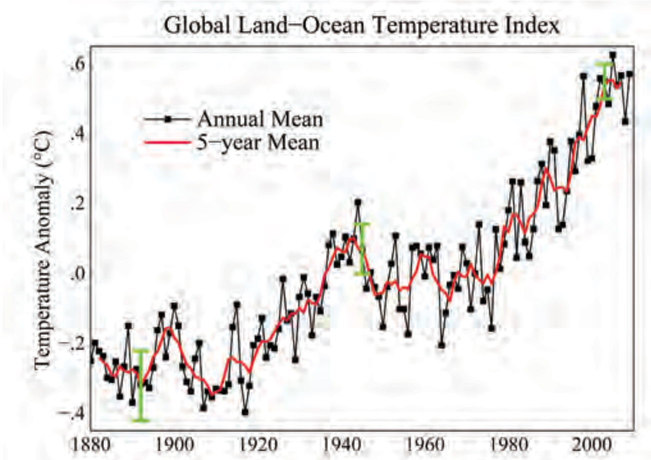
The scientific data does not support the claim Earth has been cooling since 1998 and in fact strongly shows a warming trend.

First, it's important to note that many climate scientists don't think 1998 was even the warmest year on record. Scientists at NASA's Goddard Institute for Space Studies (GISS) have determined that 2005 was actually the warmest and that 1998 is in a statistical tie for second place with four other years: 2002, 2003, 2006, and 2007. The difference between their analysis and that of the U.K. researchers is complicated, but basically boils down to the way each handles missing weather data in the historical record. In the GISS analysis, five years since 1998 were as warm or warmer, clearly not a sign of global cooling.

Rong Fu, an expert in climate observations, also noted that you can't tell anything about climate from one year. For example, 1998 was an unusually warm year because of a strong El Nino.

"That was an anomalous year," said Fu. "It doesn't represent the state of the climate for the 1990s."

Likewise, 2008 was a cooler year, relative to the rest of its decade, because of La Nina, the flipside of El Nino. And 2009, despite regional chills, was still one of the hottest years on record from a global perspective. To understand how climate is really changing, Fu says, you have to smooth out those big year to year swings by taking a running average. In other words, you average each year's temperature with the temperatures from at least a few years before and a few years after.



When scientists take a 5 year running average of global surface temperatures (red line), Earth has clearly been warming for several decades. Source: NASA's Goddard Institute for Space Studies (GISS).

Scientists at GISS compile just such a graph for the Global Land-Ocean Temperature Index (see graph). The red line, which indicates a 5 year running average, shows a clear and strong warming trend from 1998 through the middle of the past decade (as far as a 5-year running average can go because each year relies on data from five years into the future). The warming trend is nothing new. Scientists trace it back several decades before 1998.

Share Your Thoughts

You can share your thoughts on this article online—and pose additional questions to the researchers. We've created an "Ask the Scientist" forum for questions about climate science. You can find it from the Web site of the Climate System Science group at the Jackson School or go directly to:

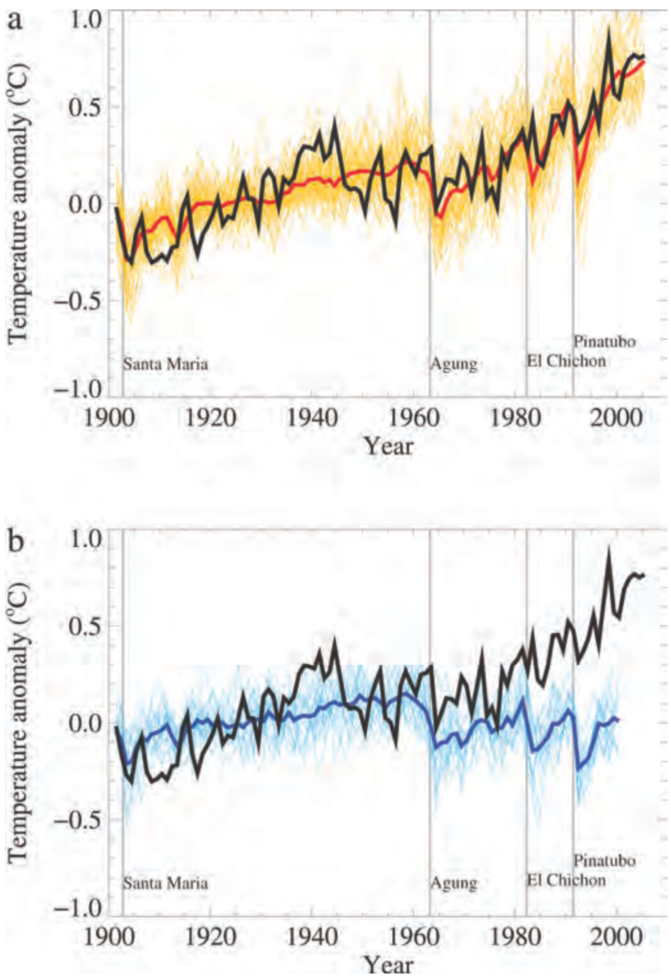
www.jsg.utexas.edu/climateforum

Another key in establishing long term trends is to show that it is independent of specific start and end dates. In this case, if you start with the year 1997 or the year 1999 and then run forward to the present, the apparent cooling trend evaporates and you're left with a clear warming trend.

Rong Fu

Myth 2. Increased carbon dioxide (CO_2) can't contribute to global warming: It's already already maxed out as a factor and besides, water vapor is more consequential.

Some climate skeptics claim that the carbon dioxide (CO_2) currently in the atmosphere is already "saturated" in its ability to absorb longwave radiation from Earth and therefore additional CO_2 in the air won't make a difference—won't, that is, absorb more heat. They also argue that water vapor is a more potent greenhouse gas and therefore increases in CO_2 shouldn't be a concern. These



When researchers remove greenhouse gases from the climate models, the observed warming over the last century (in black) evaporates. The red line represents model output with greenhouse gases, the blue line represents model output without. (Stott et al. 2006b)

claims have been made in recent years by Hungarian physicist Ferenc Miskoczi and other scientists. They were repeated in the Skeptic Handbook, published in 2009 by science writer Joanne Nova. Yet the seed of the argument actually goes back more than a century.

In 1900, scientists published results of a laboratory experiment interpreted at the time to signify that all of the long wavelength radiation emitted by Earth is absorbed by the atmosphere already, and that therefore, adding more CO_2 couldn't possibly make a difference.

Here's what the scientists did in that early experiment: They sent infrared light through a foot long (30 cm) tube containing a small concentration of CO_2 meant to simulate Earth's atmosphere and then measured how much radiation made it through to the other end. Next, they cut the amount of CO_2 by a third and measured how much radiation made it through. As it turned out, the results were nearly the same. Therefore, they reasoned, CO_2 is already maxed out in its ability to further warm the planet.

The flaw, noted climate modeling expert Charles Jackson, was simplifying the atmosphere down into something like a short tube or a thin sheet of glass. In reality, the atmosphere is thick with many layers. As radiation makes its way up through the atmosphere, it gets absorbed and re-emitted many times. And it's re-emitted in all directions. More CO_2 near the surface doesn't make a big difference, but higher up in the atmosphere, more CO_2 means more heat is absorbed and re-emitted (both up and down). The net effect is that it becomes harder for Earth to shed its heat back out to space.

Then there's water vapor. It absorbs a wider range of wavelengths of radiation than CO_2 and is more abundant overall in the atmosphere. So it seems logical that water vapor would have a larger role in climate change than CO_2.

But, Jackson noted, Air Force experiments in the 1940s showed that in the upper atmosphere—where Earth's heat is released into space—there is little water vapor and at lower pressures, it is less able to absorb radiation. So CO_2 turns out to be more important than water vapor in the region that counts.

That isn't to say that water vapor doesn't matter. All climate models incorporate its effects in their simulations. The difference is that climate scientists consider it a feedback rather than a main driver of climate change. That's because of observations showing that regardless of changes in global temperatures, global relative humidity stays fairly constant.

Myth 3. You can't trust climate models because they do a lousy job representing clouds and aerosols.

Climate modelers have traditionally had a hard time incorporating clouds because clouds are very complex. On the one hand, by reflecting sunlight, they tend to cool Earth. On the other, they tend to hold in heat from the surface, which is why cloudy nights tend to be warmer than clear nights. The models also divide the atmosphere up into blocks much larger than clouds, so it's difficult to create realistically sized clouds.

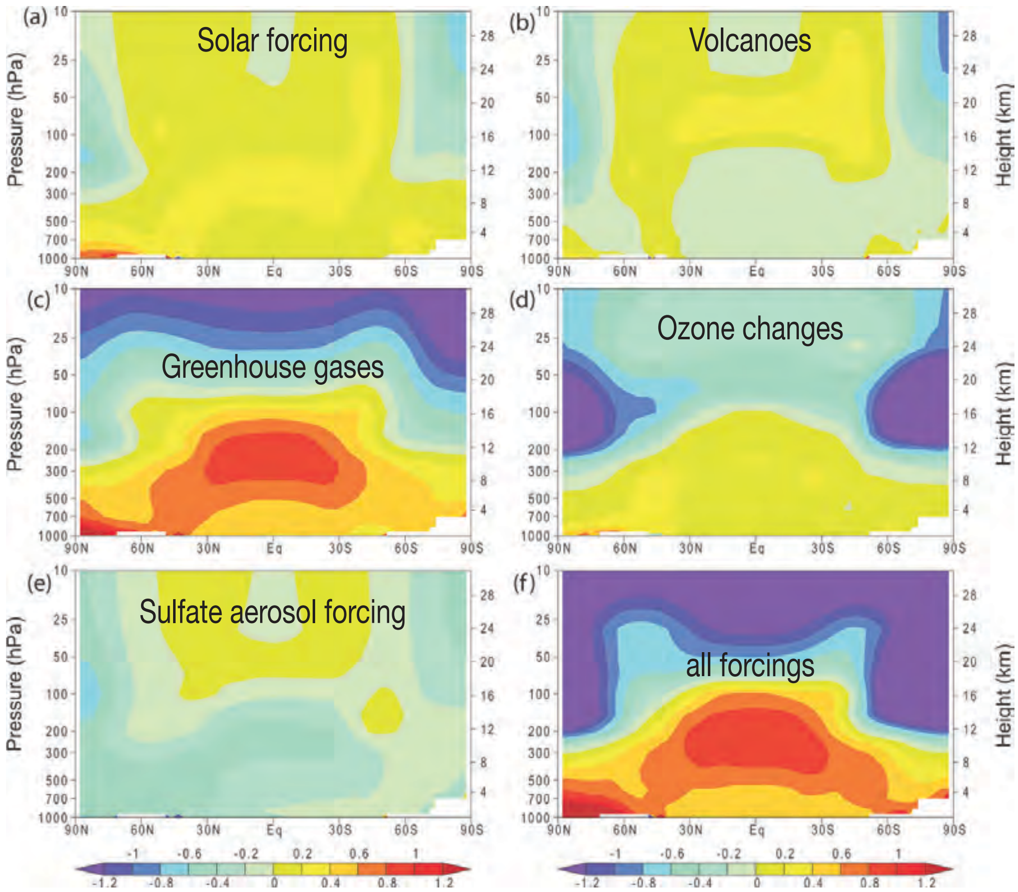
Aerosols—microscopic particles produced by volcanoes, burning fossil fuels and other sources—are a challenge to model too. They tend to have a cooling effect because they reflect sunlight and can also form the seeds for reflective water droplets. Perhaps the models are missing important effects from clouds and aerosols that would counteract the effects of greenhouse gases on global temperatures.

Jackson acknowledged that climate models do have uncertainties and don't create perfect predictions about future climate. But despite their shortcomings, when used to simulate past climate, the

Charles Jackson

models get the basic patterns correct. The differences tend to come in the amplitudes, not the general patterns.

One example is the pattern of global temperature increase of the past century. Jackson noted that when researchers remove greenhouse gases from the climate models, leaving behind all the known natural sources of variability, the observed warming over the last century evaporates.



Each major driver of climate leaves its own unique fingerprint on atmospheric temperatures. The fingerprint for greenhouse gases turns out to be very distinct from all the others—warming of the upper troposphere near the equator and cooling in the upper atmosphere. Red indicates warming and purple indicates cooling. (Santer et al. 2003)

Another type of pattern is based on how temperatures change over time with respect to depth in the atmosphere and latitude. This is sometimes represented in color coded charts with latitude running along the bottom and depth in the atmosphere running up the side (see figure). Red indicates warming and purple indicates cooling. Each major driver of climate (solar activity, volcanoes, greenhouse gases, ozone, and sulfate aerosols) has its own unique fingerprint on this kind of image. These fingerprints have been revealed by running the climate models with just one forcing and leaving the others out. The fingerprint for greenhouse gases turns out to be very distinct from all the others—warming of the upper troposphere near the equator and cooling in the upper atmosphere. Rong Fu later showed how this distinct fingerprint of greenhouse gasses shows up loud and clear in direct observations of the atmosphere from satellites, indicating that these gases are playing a major role in climate change.

Other patterns that climate models accurately recreate in past climate include warming of the oceans, rising sea levels, decreased sea ice and snow cover, retreating ice sheets and glaciers, changes in atmospheric circulation patterns, and increased heavy precipitation. The fact that climate models get these patterns right gives modelers some confidence in their forecasts of future climate.

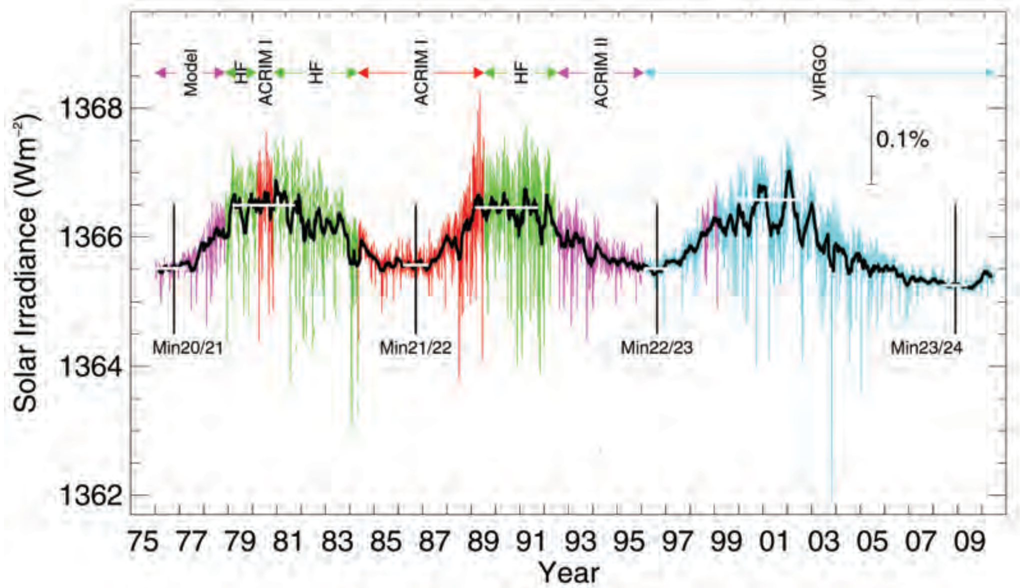
Myth 4. There have been big climate changes in the past, such as the Little Ice Age and the Medieval Warm Period, so why can't recent climate changes just be explained by natural variability?

People who dispute evidence of recent global warming sometimes point to two episodes in the past 1,000 years called the Little Ice Age and the Medieval Warm Period—times when northern hemisphere temperatures were higher or lower than average for decades or even centuries—as examples of internal variability, a kind of natural randomness in the climate system that can't be explained by any specific forcing. If true, perhaps internal variability could explain the current rapid global warming, skeptics argue. In other words, maybe our current warming is just an unlucky roll of the dice, a blip rather than a long term trend.

Climate scientists now understand that the Medieval Warm Period was caused by an increase in solar radiation and a decrease in volcanic activity, which both promote warming. Other evidence suggests ocean circulation patterns shifted to bring warmer seawater into the North Atlantic. As we'll see in the next section, those kinds of natural changes have not been detected in the past few decades. Jackson noted that when computer models take into account paleoclimatologists' reconstructions of solar irradiance and volcanoes for the past 1,000 years, the models reproduce the Little Ice Age and Medieval Warm Period. Those events turn out to not be random noise after all.

Myth 5. Natural forces such as solar variability, cosmic rays or volcanic eruptions can explain the observed warming.

Nearly all of the heat at the surface of Earth comes from radiation from the sun. Perhaps, as one hypothesis goes, that radiation has become more intense in recent decades and is making the planet warmer. A second, more complicated hypothesis involving the sun proposes that higher solar activity tends to suppress the levels of cosmic rays, high energy particles from space, hitting our



Above: Apart from the regular 11-year solar activity cycle, Total Solar Irradiance (TSI) has stayed essentially flat since the 1970s, at the same time that global temperatures have risen most rapidly in the past century. TSI is the sun's brightness (as measured daily by earth orbiting satellites) summed across all the wavelengths of the electromagnetic spectrum. (C. Fröhlich)

atmosphere. Cosmic rays help form water droplets and clouds. Clouds are thought to have an overall cooling effect on the planet. Still with us? So in this view, if the sun is more active, then there are fewer cosmic rays, less cloud cover, and a warmer Earth.

Rong Fu noted that solar irradiance and cosmic rays have stayed essentially flat since the 1970s, at the same time that global temperatures have risen most rapidly in the past century. Laboratory experiments and paleoclimate records have failed to convince the climate community that the cosmic ray hypothesis is valid. Also, the cosmic ray hypothesis fails to explain why Earth is warming more at night than during the daytime, a fact which is consistent with the warming effects of human produced greenhouse gas emissions.

Ginny Catania, an expert on polar ice sheets and climate observations, added that sunspot activity—another way of measuring solar activity based on counting dark spots on the sun—does vary in a regular 11-year cycle, but that since at least 1950, average sunspot activity has remained flat. According to the Intergovernmental Panel on Climate Change, from 1950 to 2005, it is "exceptionally unlikely (<1% chance) that the natural variability in the Sun spot cycle has had a warming influence comparable to that from anthropogenic greenhouse gases."

There's a third hypothesis here about the effect of volcanoes. Volcanoes produce aerosols that tend to cool the atmosphere, so if there were less aerosols the planet would actually warm. Perhaps volcanoes are less active now than they were 50 or 100 years ago.

Kerry Cook

Volcanic aerosols have actually increased in the atmosphere since the 1960s, noted Fu, which would tend to lead to global cooling, not warming.

Myth 6. The urban heat island effect or other land use changes can explain the observed warming.

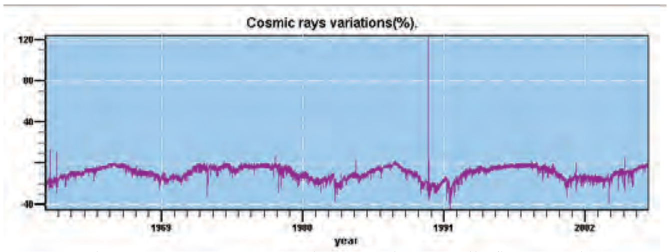
The urban heat island effect is a well documented phenomenon caused by roads and buildings absorbing more heat than undeveloped land and vegetation. It causes cities to be warmer than surrounding countryside and can even influence rainfall patterns. Perhaps, the argument goes, ground based weather stations have been systematically measuring a rise in temperature not from a global effect but from local land use changes.

Climate scientists do make corrections to weather station data based on the urban heat island effect. But what if they aren't correcting enough?

Fu noted scientists observe the greatest rates of warming in some of the least populated areas, such as the Arctic and southern Africa. Those trends can't be explained by land use change or the urban heat island effect. Also, if you remove all ground based weather stations that are within 6 kilometers of populations over 30,000 people, on the assumption that these are the stations most likely to be affected by the urban heat island effect, the warming trends remain essentially the same.

Myth 7. Natural ocean variability can explain the observed warming.

The oceans are the largest single reservoir of heat in the climate system. And they do have internal cycles of variability, such as the Pacific Decadal Oscillation (PDO) and the Atlantic Multi-decadal Oscillation (AMO). These cycles have impacts on the sea surface temperature in specific regions that vary from year to year and even from decade to decade. So perhaps, the argument goes, we



Below: Cosmic ray intensity has stayed essentially flat since the 1960s, at the same time that global temperatures have risen most rapidly in the past century. (Source: Climax Neutron Monitor)

just happen to be in a warm period that will last a few decades and the oceans will eventually switch back to a cool period.

Fu said the top 100 meters of the oceans are experiencing an upward trend in temperature all across the planet. She said that cannot be explained by any known ocean cycles.

The AMO is in a warm phase, but the last time that happened, in the mid 20th century, only the Arctic experienced warming. It wasn't a global effect. This time, noted Catania, the entire planet is warming and the size of the warming is many times larger.

Catania conducts research on Greenland's ice sheet. She described a research station on the northeastern part of the ice sheet that doesn't appear to be correlated with the AMO and yet has experienced twice the warming that the rest of the planet has in the past 150 years. This scale of warming is, however, predicted by global climate models that include human produced emissions of greenhouse gases.

Myth 8. In the past, global temperatures rose first and then carbon dioxide levels rose later. Therefore, rising temperatures cause higher CO_2 levels, not the other way around.

Ice cores from Lake Vostok in Antarctica record surface temperatures and atmospheric concentrations of CO_2 going back over 800,000 years. During that time, several ice ages came and went. After each ice age ended, temperatures rose first and then several centuries later, CO_2 concentrations rose. This lag, some skeptics conclude, proves that CO_2 increases are caused by global warming, not the other way around.

According to Kerry Cook, it isn't an either/or proposition. Climate variations can have many different causes, which are known as "climate forcing factors." The climate forcings for ice ages and warmer periods are well-known variations in Earth's orbital parameters (the eccentricity of its orbit around the sun, the tilt of its axis of rotation, and the season during which Earth is closest to the sun). These factors can be accurately calculated for any past or future time, and they vary on time scales ranging from 23,000 years to 400,000 years. The amount and distribution of solar radiation that reaches Earth changes with the orbital parameters, causing climate variations on these same time scales (tens of thousands of years).

During glacial (cool) periods on Earth, atmospheric CO_2 levels are lower, and during interglacial (warm) periods they are higher. That's true in part because during warmer periods, the oceans store less dissolved CO_2, just as your glass of soda releases its CO_2 and goes flat when it warms to room temperature. Warming soils also release more CO_2. So it makes perfect sense that in the past, CO_2 variations followed temperature variations. The role of CO_2 in natural glacial/interglacial climate change is to amplify the climate change, making warm periods somewhat warmer. So changes in Earth's orbital parameters likely kicked off the warmer periods and rising CO_2 likely boosted the effects.

That doesn't prove that CO_2 can't cause global warming. In fact, since past natural warmings took about 5,000 years to complete, CO_2 and temperature actually rose together for about 90% of the time. Climate scientists think much of the warming in ice core records during interglacials is due to CO_2.

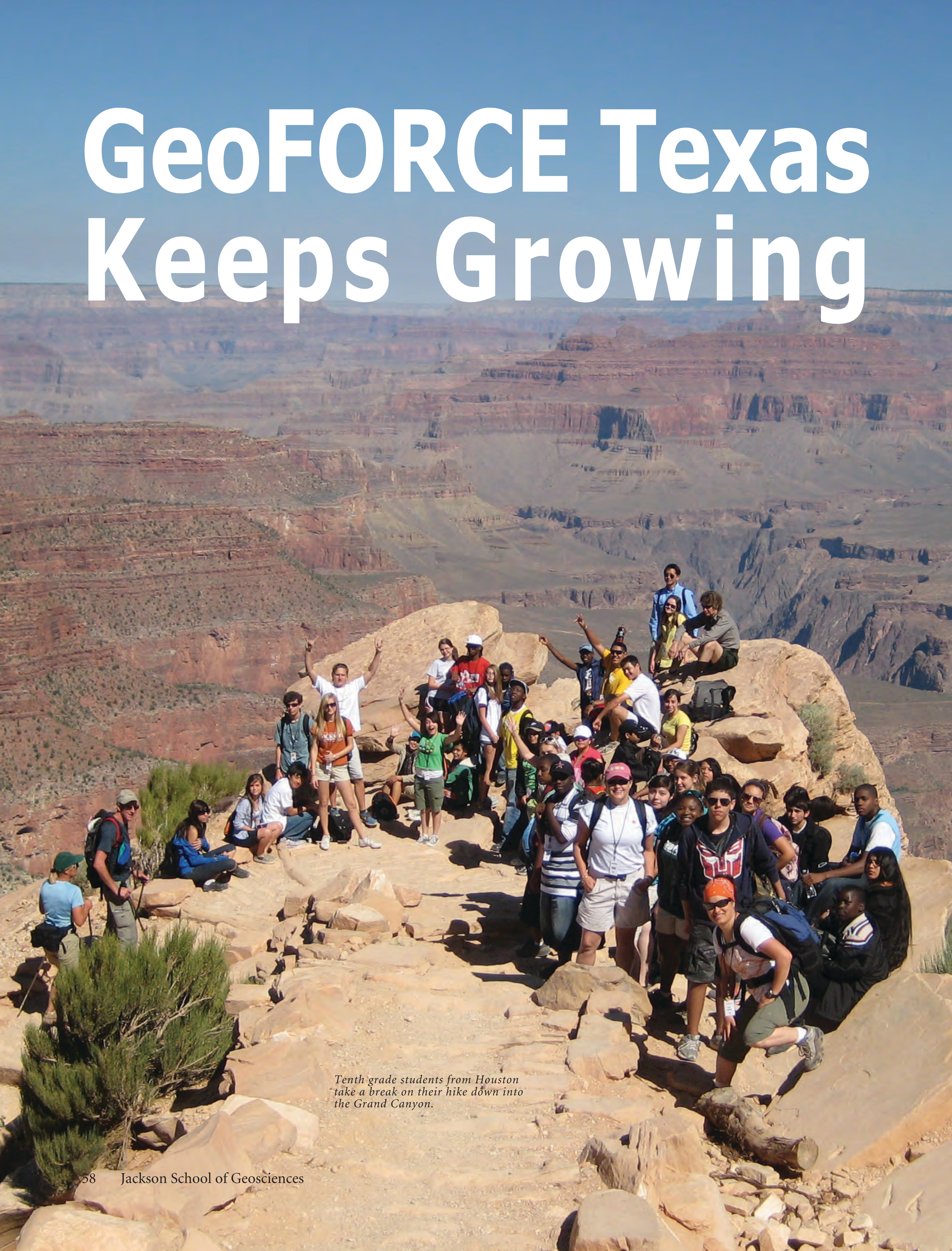
The game has changed dramatically in recent decades. There is no lag between rising temperatures and rising CO_2. Both have spiked dramatically in the past 50 years. The rate of change and the lack of a lag are exactly what climate scientists theorize should happen if CO_2 takes over as the main climate forcing.

There are several reasons that it is useful to refer to the ice core records when we are thinking about CO_2-induced climate change. One is to simply understand that global climate can change, and that a change in the globally-averaged surface temperature of just a few degrees implies a huge change in climate. The difference between a glacial and an interglacial climate is only about 5°C (about 9°F), which is comparable to predicted changes in globally-averaged temperature over the coming decades due to increasing greenhouse gas concentrations.

We also learn from the ice core record that these natural, long-period changes take CO_2 levels from about 200 parts per million by volume (ppmv) during a glacial (cool) period to about 280 ppmv during an interglacial (warm). This provides perspective on the current atmospheric CO_2 concentration of about 390 ppmv, showing that it is far outside the range of natural variations even on time scales of tens of thousands of years. ✷

Ginny Catania

GeoFORCE Texas Keeps Growing



Tenth grade students from Houston take a break on their hike down into the Grand Canyon.

GeoFORCE Texas, one of the nation's largest geosciences pipeline programs, has just wrapped up its biggest summer of field trips ever. The program began in 2005 with 80 students from southwest Texas. In 2008, it expanded to include students from the Houston area. This past summer, nearly 600 students from the two regions fanned out across the country to see spectacular geology first hand.

GeoFORCE, hosted by the Jackson School and supported by energy companies, government agencies, and private foundations, engages honor students from predominantly minority serving schools on geological field trips to educate and excite them about science. The program is designed to increase the number and diversity of students pursuing college degrees in math and science, especially the earth sciences. Students who maintain academic standing meet each summer for one week, traveling to UT Austin and several locations of geologic significance around the U.S. Thanks to the sponsors, the program is free with all expenses paid for admitted students.

GeoFORCE has just reached a second major milestone as the first cohort of Houston students to complete the program headed to college this fall. (Last year the first cohort of southwest Texas students attended college.) Kanavis Alston, a 2010 graduate of Madison High School in Houston, was already interested in science, primarily biology, before his two summers in the GeoFORCE program. Now, as a freshman at The University of Texas at Austin, he's planning on working in the business side of the oil industry.

"I was inspired by the people from the oil industry that went on the trips," he says. "I liked hearing their stories."

Of 40 college-bound GeoFORCE students from the Houston area, 20 are majoring in STEM fields (science, technology, engineering or math), 7 are attending UT Austin, and 2 are majors in the Jackson School.

Alston says in his high school, he was used to being one of the smarter kids in class. GeoFORCE was different.

"It was my first time being around that many intelligent people," he says. "On the trip, everyone wanted to learn and they were engaged in all the lessons. It was refreshing."

GeoFORCE's southwest region graduated 72 students this year, of which 22 are attending UT Austin (15 in STEM fields) and 7 are in the Jackson School. Jeff Sitgreaves, a 2010 GeoFORCE graduate from Brackettville in southwest Texas is majoring in geology at UT Austin.

"If it wasn't for GeoFORCE and all of the great things they do alongside the Jackson School, I would have never considered geology," he says. "I realized by my last GeoFORCE trip that geology, the Jackson School, and The University of Texas at Austin were for me."

Sitgreaves says the geology he was learning in the field was at a higher level than he realized.

"It has been great to sit in class at UT and listen to the professor talk about a given subject and then be able to relate that to the things I have already learned and seen as a part of GeoFORCE," he says. "So, in that respect not only have I been able to gain wonderful experiences, I have also been given a head start because of all the great things that GeoFORCE has to offer."

Charlie Kerans (right), professor in the Jackson School, teaches 9th graders from Houston at Lover's Key, Florida.

Study, Study, Study

In a third milestone for GeoFORCE, students from the first class to graduate from the program have now completed their first year of college. At the time of writing, staff members had reached 62 of the 75 students who started college in fall 2009. Of those, all but four were planning to continue their college work. (One, who had joined GeoFORCE for one summer as a senior in high school, has already completed a bachelor's degree from UT Austin. One graduated with a two year junior college degree, one left for work, and the fourth joined the Air Force.)

"My first year at college was amazing while at the same time somewhat difficult," said Luciano Esquivel, biology major at UT Austin and 2009 GeoFORCE graduate. "The most difficult thing was getting used to studying, something I'm still trying to work on. I was really shocked at how much of a leap high school was all the way to college. It was as if I had entered a whole new world."

GeoFORCE students take an exam at the end of each summer's field trip to show they understand the material. Esquivel said this forced him to study each night to prepare, a practice which helped him get ready for college. When he started participating in GeoFORCE, Esquivel already knew he wanted to go to college to study biology. GeoFORCE helped confirm his interest in science and influenced his decision to enroll at UT Austin. He is now gravitating towards neurobiology.

"One of the best ways that GeoFORCE helped me to prepare for college was simply that it challenged me to think critically about things," said Ruth Montgomery, undergraduate at UT Austin and 2009 GeoFORCE graduate. "This is an essential college skill and I feel my experience in GeoFORCE, as well as other experiences, helped me learn to think in such a way."

Montgomery, who is gravitating towards becoming a registered dietician, said GeoFORCE also taught her that to succeed in anything, but especially in college, you have to want to learn.

"No one is going to sit down with you daily and make you learn," she said. "It has to be something you want to do and if you don't, there is always another student who does."

Tools for Success

Starting this school year, high school seniors are required to take


Left: Terry Quinn (left), director of the Institute for Geophysics, with 12th Graders at Windley Key Geological State Park, Florida.
Right: Assistant Secretary of the Interior for Water and Science Anne Castle (right) visited GeoFORCE students at Harpers Ferry.

a fourth year of science to graduate. To fulfill that requirement, schools can offer a new course called Earth and Space Science. In practice, though, there are few teachers qualified to teach the course or school districts that can afford it. The situation is worse in many of the same underserved schools that GeoFORCE targets.

"We have these kids in schools that just don't have the resources to offer a strong science class for seniors," said Eleanour Snow, associate director of outreach for the Jackson School. "They provide the state mandated biology, physics, and chemistry. But most of our kids have already had that by their senior year and are down to taking auto shop or home economics."

Doug Ratcliff, director of outreach for the Jackson School, asked Snow if she could create an online course that would provide GeoFORCE students with credit for a fourth year of science, as well as credit for college.

"My first assignment was to help them work out how to teach an online science class to high school seniors," said Snow.

The new course, which she has now taught two years, primarily covers physical geology, planetary geology, and current issues, such as the Gulf oil spill or climate change. Last year, 40 students took her course.

Students read the textbook, watch short supplementary presentations online, and then conduct investigations in which they apply what they've learned. In one such investigation, they use real climate data taken from an Antarctic ice core, create graphs, and analyze the results.

Though most of the work is done online, Snow does take the students on field trips to rivers, volcanoes, mines, and fossil sites. There are also lab kits at each school with rocks, minerals, and maps that the students use for hands-on lessons.

Step Up

Dean Mosher announced in July that Snow would become the first associate director of outreach for the Jackson School. Her main focus will be to support GeoFORCE students both during high school and throughout college as a mentor and advisor.

"One of the things we learned from the first group of students that went to college is that getting them to college is not enough," said Snow. "We have to make sure they get through college and get added to the workforce." She noted that only one in three Texas students who enroll in college finish.

"We want to be sure our numbers for GeoFORCE are a heck of a lot higher than that," she said.

Undergraduate Ruth Montgomery had a wakeup call when she enrolled in calculus her first semester at UT Austin. She was lost from the start. "This was very difficult for me to accept because math had always been my favorite subject and I had excelled at it," she said. "I was used to being the one helping others understand the material, not the one in desperate need of help understanding."

She made the hard decision to "Q-drop" the class. She took it again the next semester and did fine.

"My second semester was vastly different," she said. "I tried my best to read the class material as we went rather than letting it pile up until the day before a test. I taught myself to study, which was quite a new thing for me. Overall, my second semester went a lot better than the first."

Snow is now seeking funding for what she calls a "step up to college academy" next summer for GeoFORCE graduates planning to major in science, engineering, or math. Students will be given an assessment of their math and science skills and then will work for several weeks with dynamic teachers who will help bring their skills up to college level.

"So they can step into that first class in college confidently and do well and not fail that first exam," she said. "You don't want your freshmen to feel like a failure two months into the school year." ✷

Boosting Diversity

GeoFORCE is a diversity program, designed to increase participation in earth science, especially by minorities. In the past two years, the program has sent 27 students to college declaring geology majors. Of these, 18 are Hispanic and three African American. The Jackson School also hosts minority students from a sister geoscience pipeline program based at Fort Valley State University. From that partnership the Jackson School graduated two African Americans (one with a master's degree) and has four currently enrolled as seniors. To put that in perspective, U.S. universities award about 65 B.S. degrees in geology to African Americans and 130 to Hispanics each year. Assuming the students continue to degree completion, the Jackson School is on target to supply a tenth of the nation's minority geoscience degrees.

GeoFORCE Students Thank Their 2010 Instructors and Field Participants

Sponsor Participants in the Field

Gil Apps, BP
Liz Baker, Shell
Martha Barnes, Marathon
Denise Butler, Shell
Danielle Carpenter, Chevron
Chuck Caughey, ConocoPhillips
Nysha Chaderton, ExxonMobil
Laura DeMott, ExxonMobil
Dominic Druke, Shell
Gary Fleeger, Pennsylvania Geological Survey
Jack Grow, Shell
John Haro, HISD
Carolina Isaza, Shell
Charlotte Jolley, Shell
Jocelyn R. Lewis-Miller, Snyder Associated Companies, Inc.
Shelley McKinley, HISD
Anna Morisani, Shell
Randy Orndorff, USGS
Lydia Quintana, USGS
Laura Reich, Marathon
Bud Scherr, Valence Operating Company
Heather Scherr, Valence Operating Company

Field Instructors

Pat Bobeck, Consultant
Elizabeth Catlos, Jackson School
Tiffany Caudle, Jackson School
Peter Flaig, Jackson School
Charlie Kerans, Jackson School
Ernie Lundelius, Jackson School
Jeff Paine, Jackson School
Terry Quinn, Jackson School
Jay Raney, Jackson School (retired)
Jim Sansom, Consultant
Chock Woodruff, Consultant
Laura Zahm, Jackson School

Meet Eleanour Snow

Even as a child, Eleanour Snow wanted to be a teacher. She got her doctorate in geology from Brown University and went straight into academia, teaching structural geology and mineralogy, and doing research in experimental mineral deformation at the University of Arizona and then the University of South Florida (USF). This was her dream job.

One day, the director for geochemistry programs at the National Science Foundation visited the campus. She asked him if he had any advice about research directions for a young scientist in her particular field. He told her, “Find another field.”

Snow took it in stride. It was actually meant as a friendly warning. Federal money for basic science research was drying up. So she decided to go into earth science education, an area that was just beginning to take off.

In 1995, she created the first Internet based distance learning course at USF. She developed online courses in oceanography and environmental science, as well as a traditional in-person course for non-science majors called Science, Earth, and Life. Another course she taught focused on how geology has affected the politics, history, and culture of Africa.

Her online courses aren’t just a series of lectures and quizzes, but are designed to be interactive and involve problem solving. Enrollments have been as high as 400, but ironically, she feels that she gets to know the students better in an online class than in a traditional classroom setting. Through emails and live online chats, students tend to be more open about themselves and ask more questions.

Snow and her husband Terry Quinn, now director of the Institute for Geophysics, came to Texas in 2005 on a sabbatical from USF and never left. In that time, she has developed an online forum for TXESS Revolution, a program that trains high school science teachers in minority serving schools. She has also developed an online course for GeoFORCE Texas students giving them dual high school and college credit in earth science. And she has continued teaching her online courses at USF.

Now, 15 years after her big career shift, Snow has just been selected to be the first associate director for outreach at the Jackson School.

“I can’t imagine a better place to be,” she said. “I’m looking at the last quarter of my working life and thinking this is something really important that’s really changing lives and that’s exactly where I want to be. And no matter what path I might have taken to get here, this is where I would want to end up. So it worked ultimately.”

Enduring Excellence

Breadth and Depth Mark UT Austin's Paleontology Program as One of the Best

The Jackson School's paleontology faculty, research scientists, and emeritus faculty with current graduate students and post-docs. In addition to Jackson School scientists, the university employs nine more faculty and scientists working in paleontology in other departments.

At a time when university paleontology programs are being downsized or eliminated, The University of Texas at Austin's is thriving. Last year, the program added Julia Clarke, a rising star studying the evolution of birds and dinosaurs, and Matt Brown, a fossil preparator who honed his skills at Chicago's Field Museum.

Brown and others are pioneering the use of CT scans to guide them in preparing fossils, making UT Austin one of the few universities— if not the only one—routinely doing this. (Visit www.jsg.utexas.edu for a special feature on this exciting new process.)

The university's vertebrate and non-vertebrate paleontological collections, among the seven largest in the country, continue to grow as scientists and students go into the field each year and unearth more material from the Southwestern U.S., South America, Australia, Antarctica, and Asia.

The strength of the program was reflected in the choice of the university to host the Society of Vertebrate Paleontology's annual conference in 2007 and the triennial International Congress on Rudists in 2005.

Since 1909, when the first paleontology course was taught at the university, UT Austin has graduated more than 400 master's and Ph.D. students in paleontology—more than other highly ranked programs such as Harvard or the University of California at Berkeley. There are currently 14 paleontology graduate students in the Jackson School alone.

The number of faculty, researchers and staff dedicated to paleontology across the university is tremendous by academic standards. These include nine faculty members (four in the Jackson School, three in the College of Liberal Arts, two in Natural Sciences), the director of the Texas Natural Science Center, two collections managers, several CT lab researchers, a fossil preparator, and a museum educator. Emeritus professors Ernie Lundelius and Wann Langston continue to push forward in their research.

"Because of our outstanding students, our size, and the breadth of research both within the Jackson School and across the university campus, we are one of the strongest paleontology programs in the country," says Rowe. "We have an amazing heritage of past discoveries, but as strong as our tradition is, thanks to innovative investment in technology and brilliant new faculty, I believe the best is yet to come."

Following are snapshots of research projects by the four faculty members in the Jackson School.

Tim Rowe uncovers a limb bone of Sarahsaurus, a new species of sauropodomorph dinosaur, at a site in the Early Jurassic Kayenta Formation (about 180 million years old) in northern Arizona.

A Peek Inside

When Tim Rowe picked up the football-sized egg in his Washington hotel room and gently tilted it, he could hear something tumbling inside. He was taking it, one of only a handful of completely intact eggs of the extinct Elephant bird of Madagascar, from National Geographic's Explorers Hall to Austin to take a three dimensional X-ray. On the airplane, Rowe flew coach. The egg flew in an extra seat in the cockpit.

Rowe and his master's student Amy Balanoff scanned the egg at the High Resolution X-Ray CT facility (UTCT), a National Science Foundation (NSF) shared multi-user facility co-founded by Rowe, Bill Carlson, professor of geology, and John Kappelman, professor of anthropology. In the scans, you can clearly see a jumble of bones, the remains of an Elephant bird embryo. The researchers digitally picked out individual bones and then measured them to learn about how the bird's embryos developed.

Fully grown Elephant birds were twice as tall as humans and weighed about 1,000 pounds. The CT data revealed that one key to

Why Do We Need Paleontology?

Paleontology has been a central part of geology since British scientist William Smith first showed that geological strata could be identified based on the fossils they contained. Because they change through time, fossils put a date stamp on a particular layer of Earth in which they occur.

"We are the time keepers for the Earth sciences," says Tim Rowe, professor and director of the university's Vertebrate Paleontology Laboratory (VPL).

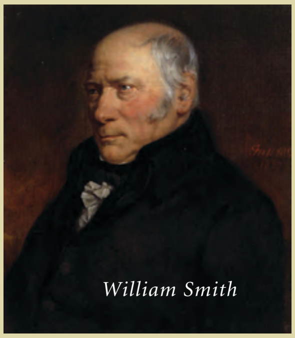
In the early days, paleontology was used to make geologic maps showing the ages of rocks at the surface. The maps made it easier to locate valuable mineral deposits such as gold, copper, coal, and oil. Fossils still provide useful information in the search for natural resources.

Fossils also helped shift our view of the age of Earth and of life itself from thousands of years to thousands of millions of years. They showed us that the story of our world wasn't short and static, but rather a grand saga full of change, catastrophe, and surprise.

Paleontological dating continues to be an important tool. There are all sorts of scientific questions about earth processes that can only be answered through an understanding of when things happened. When did this earthquake happen? When did these continents start to break apart? When did this ice sheet completely disappear? When did half the plants and animals on the planet die off? There are tools to date geological layers based on the decay of radioactive isotopes, but these don't work well in sedimentary rocks. Luckily those are places that tend to preserve fossils well.

"Paleontology remains the best way to get age control on your sedimentary rocks," says Chris Bell, professor in the Jackson School.

In recent decades, the use of paleontology in the earth sciences has expanded to include reconstructing past climates and environments, with the benefit of better understanding how they might change in the future. Fred Taylor, senior research scientist at the Institute for Geophysics, and Terry Quinn, the Institute's director, use fossil corals to determine past sea level.



William Smith

While paleontology remains a central part of a modern earth sciences program, it also straddles the increasingly thin boundary with life sciences.

"Paleontology is essentially geobiology," says Jim Sprinkle, professor. "It's one of these interdisciplinary areas just like geophysics which is between geology and physics, or geochemistry which is between geology and chemistry."

Even though molecular biology has made great strides in understanding the tree of life, DNA can only be analyzed reliably from the past few thousand years. Fossils remain an important tool for understanding how life evolved on this planet.

"What do you do with all of the extinct lineages?" asks Bell. "Most of everything that's ever been alive is extinct. That's the fossil record. Integrating the two is the challenge."

Systematics, using fossils to work out the evolutionary history of groups, is a major focus of Bell, Rowe, Clarke, and Sprinkle. They are each working to fill in a different part of the tree of life.

In the end, says Bell, studying the evolution of life is inherently interesting.

"Everybody should care about the history of life on Earth because we're a part of that story," he says. "People should care about it for that reason alone."

their ability to grow so large is that they grew rapidly as embryos. The best part is, the researchers didn't have to crack open the egg, which is now back on display in Washington.

This is one way CT scanners are revolutionizing paleontology. It's allowing scientists to revisit classic specimens and to continue to squeeze information from them. *Archaeopteryx* specimens dating back to the time of Darwin, for example, have been studied and restudied. When *Archaeopteryx* was scanned at the UTCT, scientists for the first time were able to determine that its brain and systems for seeing and hearing were like those of a modern bird.

The UTCT is directed by Rowe, Carlson, and Rich Ketcham, associate professor of geology, with Jessie Maisano and Matt Colbert as research scientist associates (Maisano is also facility manager). Since the lab was founded in 1997, more than 5,000 samples have been scanned, including about 2,000 fossils and biological samples. All of those scans have been useful to researchers whose institutions own the specimens, but with the advent of the Web, Rowe had the vision to make the data available to the public so that anyone could access them for research and education. With an NSF grant, he created DigiMorph (www.DigiMorph.org), a website that has grown to include visualizations and animations of more than 850 specimens. Many of the scanned items are considered the crown jewels of the museums that house them.

"Each and every image from our scanner is entirely new to science, an image never before seen, providing new insights and data on specimens that in some cases have been handled for decades or centuries by scientific luminaries," says Rowe. "I could foresee that this scanner would be important, but I never dreamed it would prove to be so powerful."

Wings to Flippers

For many years, Julia Clarke has studied one of the great evolutionary innovations in the history of life on our planet: the evolution of flight in dinosaurs and rise of the major living bird groups. One recent international collaboration provided evidence that before feathers were used for flight, they displayed color and color patterns in other dinosaurs, suggesting early feathers may have had other purposes such as attracting mates, camouflage, confusing predators, frightening prey, or establishing territory.

Now she's taking on another great evolutionary leap: the modification of wings into flippers. Penguins and one or two now-extinct groups of birds evolved the ability to "fly" through water and lost aerial flight.

"People think of these birds as flightless, and that implies these dinky little vestigial wings that aren't useful for anything," she says. "Nothing could be farther from the truth. They're actually co-opting an aerial flight stroke for a strong aquatic flight stroke."

All sorts of modifications happened along the way from aerial flying to aquatic flying, including changes in birds' bones, muscles, brain structures, inner ears, and feathers. Wing-propelled diving as it's also called is very different from aerial flying. Water is 800 times as dense as air and its resistance is about 70 times greater.

Clarke and her colleagues recently received an NSF grant to sort out how the transition from wings to flippers happened. But first they have to create a family tree for all water birds.

"So we need to use molecular sequence data and morphological data to look at the evolutionary relationships of everything from a pelican to a heron to a penguin to a loon, which is this pretty massive group," she said. They'll also describe several recently discovered extinct species of penguins in the fossil record

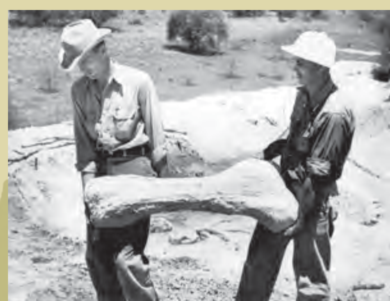
Some Highlights of Paleontology at UT Austin

1888-94: Dumble Survey assembles first significant paleontological collection in Texas

1909: First paleontology course taught at UT (F.L. Whitney)

1915: First micropaleontology course (one of two earliest in U.S.) taught at UT (F.L. Whitney)

1939: Texas Memorial Museum opens



1939-42: WPA project collects fossils for UT from 22 Texas counties

1949: Vertebrate Paleontology Laboratory (VPL) established

1949-1951: Discovery of nearly complete scimitar-toothed cat in Friesenhahn Cave (Evans, Mead, et al.)

Left to right: Ali Atamirano and Julia Clarke (right) at the fossil site for Inkayacu paracasensis*; artist reconstruction of* Inkayacu paracasensis *(illustration: Katie Browne); emperor penguins (photo: Lin Padgham).*

and place them in the family tree too. "That's the phylogenetics, that's figuring out these relationships so that we can ask these other interesting questions," she said.

Scientists have discovered that across most species of living birds, feathers have very similar mechanical properties. They bend and flex in ways that are ideally suited to flying in air. "But what we wonder is do you see changes in feather structure, material properties, and bending in response to the evolution of aquatic flight?" she asks.

Other changes might be more subtle, such as changes in the penguin brain related to how it senses its surroundings and controls its wings in the water.

Clarke didn't set out to focus on penguins. They just seemed to flock to her.

"I worked on a fossil that happened to be the earliest penguin from South America in 2003, doubling their known existence on that continent, and I never really intended to work on penguins again," she says. Then Peruvian colleagues invited her to work on what turned out to be the first giant penguin skull and other key early penguin fossils. Along the way, she ruffled feathers in the scientific community by showing that penguins once lived where they shouldn't have—near the equator during one of Earth's warmer periods.

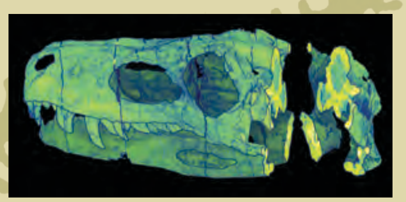
Blasted Fossils

It's hard to pinpoint exactly when Jim Sprinkle's career documenting the life and evolution of a group of extinct sea creatures called echinoderms began while he was growing up in a suburb of

1950: H.B. Stenzel produces reports on the Stone City fauna and the evolution of the gastropod *Athleta petrosa*

1971: Discovery of largest known flying animal, *Quetzalcoatlus northropi*, in Big Bend (D. Lawson)

1994: FAUNMAP, database of North American mammals for the last 40,000 years (E. Lundelius)



1997: High Resolution X-Ray CT Lab founded

1999: Non-vertebrate Paleontology Lab established

2001: Fossil fetus of an Elephant bird CT-scanned and reconstructed without breaking egg shell

2008: Early hominid Lucy CT-scanned

Left: Chris Bell and colleagues in in the Goldfields District of Western Australia (L to R): Bell, Marci Hollenshead (Northern Arizona University), Jim Mead and Sandy Swift (East Tennessee State University). Right: Moloch horridus, *one of the first animals Bell's team worked on for their project of identifying species by apomorphies.*

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 (a subgroup of echinoderms) 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.

Echinoderms are invertebrate marine animals with spines and protective cover plates of calcium carbonate. Some, like the blastoids are extinct. Others—such as starfish, sea urchins, crinoids, and sea cucumbers—live on.

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.

Now here he is, a professor in the Department of Geological Sciences for almost 40 years, and there seems to be no end in sight for finding new echinoderms, figuring out how they relate to each other, and learning how they lived. 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."

Rocking the Stability Hypothesis

In the 1980s, paleontologists studying fossils from the Quaternary Period came to a surprising conclusion: Over the last two million years, as ice ages came and went, amphibians and reptiles in much of North America experienced relatively few extinctions or changes in geographic ranges, and the origin of no new species. This is known as the Herpetofaunal Stability Hypothesis (HSH). At the same time, the geographic ranges of mammals and birds expanded and contracted in response to climate changes. Many large mammals such as ground sloths, saber-toothed cats, and mammoths went extinct.

Chris Bell took another look at the HSH in a paper published this past spring in an issue of the journal *Quaternary International* dedicated to Ernie Lundelius, an emeritus professor of paleontology at UT Austin. In it, Bell and his co-authors argue that the logic behind the HSH is circular and therefore unreliable.

For one thing, North American fossils from the Quaternary have been traditionally identified based largely on comparisons with animals currently living in the same area or region as the fossil. It's as if paleontologists were given a multiple choice test in which all possible answers are on a sheet of paper in front of them. It almost guarantees that they'll identify a fossil as being from a species that is both still living today and living in the same area.

"The stability hypothesis is, then, not a revelation or conclusion drawn from analysis of the data themselves, but is instead a predetermined outcome of a methodological approach," he writes.

Bell suggests an alternative approach for identifying fossils based on apomorphies, evolutionary traits that are unique to a particular species and all of its descendants. Unfortunately, species-level identification is often just not possible by apomorphies based on what we know so far or the completeness or preservation of a particular specimen. Bell's new focus is on gathering more apomorphic data. Until more apomorphies are discovered, Bell acknowledges, Quaternary paleontologists will be unable to answer some scientific questions using that method. But he feels this is a small price to pay for more reliable data and a way to test hypotheses derived from the fossil record.

Getting these fossil identifications right is important beyond paleontology. The way plants and animals responded to changes in climate in the recent past offers clues about what changes are in store for our planet during the current period of rapid warming.

"The insights we gain from … our work now take on renewed importance as a global community decides how, or whether, to approach the challenges predicted for coming centuries by modern climate models and an increasingly diverse assemblage of scientists," writes Bell.

Now he's applying this apomorphy-based approach to a diverse group of lizards in Australia known as agamids to see how his conclusions differ from more traditional approaches to classification. He discovered that no comprehensive skeletal collection exists for these lizards, so his first task is to build one in collaboration with colleagues from the Western Australia Museum. ✷

Fossil Treasure Troves

Despite a shift over the past century from a focus on invertebrate research and education to mainly vertebrates, the university retains a world class collection of 4.5 million invertebrate specimens, many collected by graduate students, others as part of early state geologic surveys. Of those, 20,000 are type specimens, those used to define the characteristics of new species in the scientific literature.

One of the key strengths of the invertebrate collection is its breadth. Ann Molineux, collections manager of the Non-vertebrate Paleontology Laboratory (NPL), notes geologists doing early field mapping projects collected a broad range of specimens representative of entire formations.

"They weren't just focused on getting the prettiest specimens," she says. "The collection that came from that is fabulous because it's huge, it contains a vast range of different shapes, forms, and sizes. It contains juveniles and adults of different species that provide a wealth of information for anybody wanting to see variability in a particular species."

Papers referencing specimens in these collections have increased substantially in the past decade, despite less emphasis on invertebrates within the university. Molineux attributes the increase to heightened interest from outside the university.

Scientists from north Texas recently spent several days going through a group of Texas mussels collected in the late 1800s and early 1900s, now housed in the NPL. By comparing the species and distributions of mussels from then and now, they hope to learn how changes in land use and pollution impact stream ecology.

Molineux is working to make the invertebrate collections more accessible by creating an online digital catalog and photographing the most scientifically valuable specimens.

Meanwhile, the Vertebrate Paleontology Laboratory (VPL), which houses one million specimens, is known worldwide as a major repository for unique scientific collections from the American Southwest. The VPL contains rich Quaternary cave deposits from locations such as Hall's Cave and Friesenhahn Cave, site of a famous discovery of scimitar-toothed cats in 1949. The VPL collections also include thousands of modern skeletal specimens for comparative studies. In recent years, the VPL has also absorbed orphaned collections from around the state.

While the VPL and NPL are in many ways unique, they share a common challenge of preserving vast collections for future generations. Ironically, specimens that survived millions of years in the Earth can, depending on their composition, quickly fall apart when they experience the swings in humidity and temperature common in Texas. Yet large parts of the collections are stored without adequate climate control due to a lack of space and budgetary constraints. It's a common problem at large paleontology collections across the country.

Still, fossil collections are critical for a strong paleontology program. Even when the original research project is "over" and the results are published, the specimens can still serve an important role in science. New technologies, such as CT scanning, make it possible to mine classic specimens such as the primitive bird Archeopteryx or the early human ancestor Lucy for additional information.

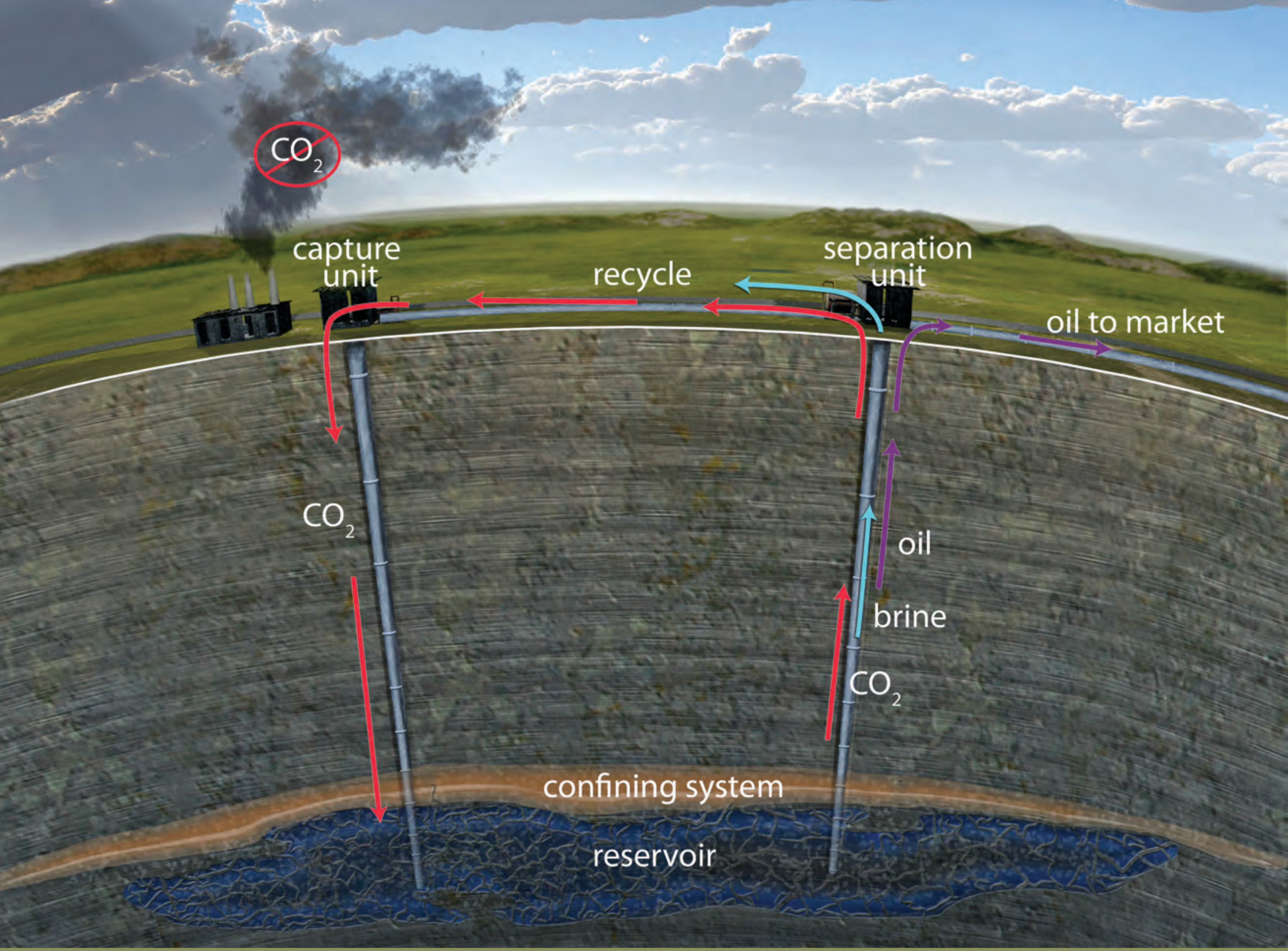
Molineux and Tim Rowe, who directs the VPL , agree that it would be a tragedy, not just for the university but for science in general, to let these world class collections deteriorate. Rowe says a fossil collection is really a research instrument.

"I think a lot of people wonder, 'Why do we keep all these old fossils around?'" he says. "But no one ever asks, 'Why do we have the McDonald Observatory?'"

He thinks of the university's astronomical observatory as a beehive, drawing researchers and students from around the world.

"A collection is an instrument in exactly the same sense," he says.

Left: Zebra and horse skulls form one of the many useful reference collections in the Vertebrate Paleontology Lab. Right: Students like Sierra Lawrence work in the Non-vertebrate Paleontology Lab researching, cataloging, and preparing specimens.



The Carbon Question

By Juli Berwald

The Gulf Coast Carbon Center Has Got Answers

A white van with an orange UT Austin logo drives down a dirt road outside Cranfield, Mississippi and pulls into a clearing. Susan Hovorka, principle investigator of the Gulf Coast Carbon Center at the Bureau of Economic Geology, steps out and surveys the site.

The calm belies two years of intense activity. During that time a massive drill rig occupied the space, boring well holes two miles below the surface. Freight trucks delivered miles of cable and pipe. Technicians labored around the clock, installing sensors, valves, and lines to connect the subsurface to the surface. But all the noise and machinery are gone now. Three red pipes snake their way above ground, a silent indication the test site is ready.

Walking toward a shipping container that serves as a nerve center for the project, Hovorka greets David Freeman, a collaborator from Sandia Technologies. They enter a room loaded with computer screens and gauges. Hovorka confirms the wells are operating properly and gives a signal.

A technician from Denbury Resources turns a large wheel opening a valve. Carbon dioxide begins its journey into the same geologic formation that once held thousands of barrels of oil. The loud hiss of compressed gas through the pipes heralds the start of the largest carbon sequestration project funded by the US Department of Energy. But, just two decades ago, the entire field of carbon sequestration was little more than an idea.

Asking the First Question

"Twenty or thirty years ago nobody knew that emitting carbon into the atmosphere from the combustion of fossil fuels was an issue," explains Hovorka.

As geology students learn, carbon, like water, moves between large reservoirs in a global-scale cycle. Plants take up CO_2 from the atmosphere and store it in their own tissues. When the plants die, their carbon is buried deep underground and, with the addition of high temperature, pressure, and a lot of time, converts to fossil fuel. Burning this fuel releases the carbon back to the atmosphere.

If the cycle were running optimally, plants would simply use up the carbon released from burning fossil fuels. But scientists in the 1980s and 1990s found that plants are already growing as fast as they can. The amount of carbon produced from fossil fuels exceeds the ability of vegetation to use it. Along with other greenhouse gases, this excess carbon contributes to a warming of Earth's atmosphere that is altering Earth's climate, ice mass, and living communities.

"So, this idea of helping the cycle close came to my attention," continues Hovorka. "You could augment the natural cycle by capturing the CO_2 and injecting it back into an environment identical or similar to those from which it came and sequester it there for very long periods of time."

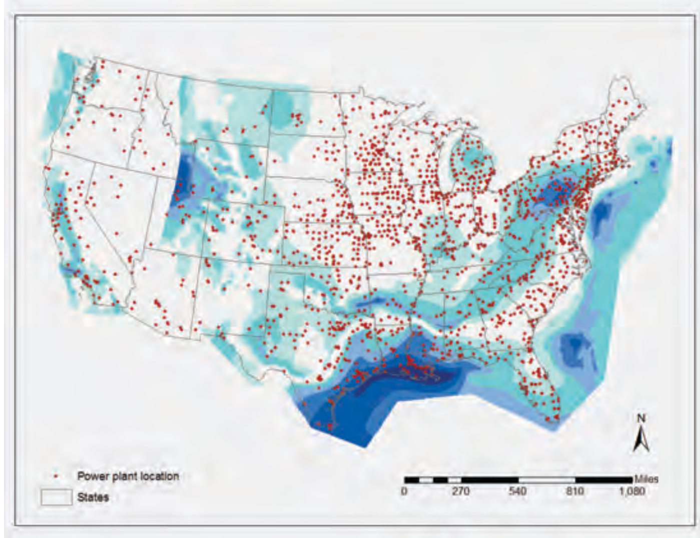
To Hovorka in 1997, this idea, called carbon capture and storage or CCS, dovetailed well with the types of projects already studied at the Bureau of Economic Geology, which has a strong track record evaluating public policy issues related to energy and the environment. Hovorka started talking with people from diverse units at the Bureau, combining her expertise in environmental geology with that of collaborators who had worked on the geology of oil and gas reservoirs. This group of investigators started by asking a lot of questions.

Laying the Groundwork

The first question concerned the economics of the resource, in this case underground space. Would CCS be worth it?

Initial results were encouraging. Early studies focused on enhanced oil recovery (EOR), in which CO_2 is injected into declining oil fields to help force out the residual oil. The work showed the gap between what it would cost to capture CO_2 and use it for EOR would be significant, but small, resulting in an addition to electricity costs, but not an inordinate increase. With a lot of oil fields in decline, especially in Texas, CCS combined with EOR had the potential for economic benefit.

The next set of questions focused on understanding the space. If you don't know the geological characteristics of a reservoir,



Sources and sinks: Red dots show sources of CO_2. Colored zones show places in the U.S. with geological formations appropriate for CCS. Texas, in particular, is well suited for injecting CO_2 into deep underground containment zones.

explains Hovorka, then that space is not really available. "We were trying to be Lewis and Clark of the underground storage reservoirs," she says.

Again, the results were positive. North America, and Texas in particular, contains a lot of underground space with the right characteristics for carbon sequestration. Referred to as containment zones, these geologic formations a mile or two below Earth's surface are also extremely well documented.

Heading into the Field

The time had come to move from paper and computers to the physical reality of CO_2 and rock formations. At about this time, the Department of Energy (DOE) was forming regional partnerships to study carbon sequestration. Hovorka and her collaborators at the Bureau, including Mark Holtz, wrote a proposal to form one of these partnerships.

The proposal was turned down, a decision that had surprising consequences. Rather than acting as a stumbling block, the failure propelled the group forward.

"It was because we didn't win that proposal that we decided to form the Gulf Coast Carbon Center," says Holtz. "We decided to do it ourselves because we knew as much about carbon sequestration as anyone else."

Coincidentally, Kinder Morgan and BP approached the group in 2002 and asked to form a center of excellence for carbon sequestration. Two years later, the Gulf Coast Carbon Center was a reality.

This newly-minted center was soon funded by DOE's National Energy Technology Laboratory (NETL) to perform a demonstration experiment of carbon sequestration in Texas's Gulf Coast. The Frio Brine Pilot Experiment (named for the formation into which CO_2 was injected) became the first major academic study of carbon sequestration. The Frio project injected 1,600 tons of carbon dioxide 1,500m below the surface. Sophisticated and aggressive monitoring showed the CO_2 behaved exactly as expected in the containment zone. No adverse health, safety, or environmental effects were detected.

But as large as that experiment was, it was still a drop in the bucket compared to the amount of CO_2 emitted by a single power plant in the same time. Hovorka wanted to know if sequestration would be safe on the scale that it would actually be used by industry. Would it interfere with public health by affecting drinking water or causing other environmental damage? Again, the answers were favorable.

In 2009, the Gulf Coast Carbon Center completed an experiment at an oil field in the Texas Panhandle where millions of tons of CO_2 have been injected for EOR since 1972.

"We found no degradation of shallow drinking water resources as a result of more than 35 years of CO_2 injection into deep geological formations," reports Rebecca Smyth, principal investigator of the study.

"Injection is very standard stuff," says Hovorka.

Most people haven't heard of the Safe Drinking Water Act of 1974 or the Underwater Injection Control Program, but they are the pieces of legislation that dictate exactly what needs to be managed when injecting anything underground. Tens of thousands of wells currently inject a variety of fluids underground under the injection program, including thousands of EOR sites.

"The reason people don't know about these programs is because they work," Hovorka explains. It was time to expand again.

Scaling Up

Today, researchers working with the Gulf Coast Carbon Center pump one million metric tons of CO_2 underground every year—the same scale industrial operators will require to make carbon sequestration economically viable.

The project in Mississippi, referred to as Cranfield phase III, is a $34 million multi-year field study of sequestration and monitoring strategies. The Cranfield study "has led the NETL program into a new phase of development, which is the large-scale demonstration project," explains Tip Meckel, a Bureau researcher and major contributor to the project. The Cranfield work is performed in conjunction with the Southeast Regional Carbon Sequestration Partnership (SECARB) with support from DOE/NETL and managed by the Southern States Energy Board (SSEB).

Along with their collaborators, the Gulf Coast Carbon Center decked out two observation wells at Cranfield with some of the most sophisticated scientific instruments ever deployed 3 kilometers (10,000 feet) underground. From electrical resistance tomography to cross well seismic imaging, almost every type of wave signal an instrument can produce is being used to measure carbon sequestration. Fluid samples are conveyed to the surface by means of a state-of-the-art sampler called a U-tube and subjected to a vast array of chemical analyses. The data is still being distilled but, "so far we have a very good history match," says Hovorka.

One significant question remaining is the best way to monitor an injection program.

"We'd like to find the canary in the coal mine," says Hovorka, which means real-time signals that assure managers know it's safe to continue injecting, and warn them if not.

A promising technique is called above zone monitoring. Similar to sneaking spies into the attic of a safe house to collect intelligence from conversations in the rooms below, above zone monitoring involves placing temperature and pressure sensors about 400 meters (1300 feet) above the confinement zone.

"Any pressure or flow communication between those formations due to lack of seal or well integrity will be picked up by the

Concentration on Collaboration

Carbon sequestration is at root a problem that involves a variety of disciplines. When Hovorka started thinking about CCS, she realized she needed information beyond her expertise in subsurface geology—to understand the economics of power plants, the chemistry of coal combustion, and energy regulation.

Today the staff at the GCCC includes stratigraphers who characterize underground containment zones, geochemists who study the chemistry of ground water and rocks, hydrogeologists who work on the movement of water deep underground and in aquifers, and modelers who develop computer programs to validate all of this information. They also include economists who study the market implications of sequestration and environmental geologists studying its risks. Other staff focus on outreach, connecting the information learned at GCCC to the broader scientific community and the public.

"We have much diversity, an abnormal amount of diversity, but it's not nearly enough." says Hovorka. So the carbon center has reached out to a broad spectrum of collaborators.

Within the university, the GCCC works closely with researchers at other units, including Bill Galloway, Patty Gainey-Curry, Matt Hornbach, and Ursula Hammes at the Jackson School and Larry Lake, Gary Pope, and Steve Bryant in the Cockrell School of Engineering, contributing everything from new geophysical techniques for measuring CO2, to characterizing how sands laid down millions of years ago form the perfect compartments for storing the gas.

In the Department of Geological Sciences, Mark Hesse teaches carbon center students multi-phase flow modeling, key to validating the assumptions of the field tests. Professors Jay Banner and Phil Bennett provide input on groundwater flow patterns ensuring injection projects will not impact aquifers.

In the larger university community, the GCCC collaborates with Gary Rochelle in the chemical engineering who is developing new methods for capturing CO_2 from power plants. David Eaton at the LBJ School looks at legislative policy. Melinda Taylor and Michael Esposito at the Law School study how laws governing sequestration might be written. Ray Orbach at UT's Energy Institute depends on the GCCC to advance solutions to today's energy problems. Mary Wheeler at the Institute for Computational Engineering and Sciences is part of the center's mathematical modeling effort.

"But UT isn't enough" Hovorka asserts. The carbon center's corporate sponsors number in the mid-teens and the center collaborates with six national laboratories, ten universities, a similar number of industries, the USGS, Department of Energy, and the EPA.

The large range of industries involved with the Center bring essential skills and experience to the programs, and in the case of Denbury, Inc. and Kinder Morgan, they act as site hosts in the field.

"We work with the best in the world," summarizes Hovorka.

Work pregresses at a $34 million Department of Energy funded research project evalutaing sequestration and monitoring strategies for long-term storage of carbon dioxide at Cranfield field in Mississippi. Here, an observation well is being drilled and fiberglass casing is waiting to be inserted and cemented inside the well.

above zone gauge first," says Meckel. Beginning prior to injection in 2008 and operating continuously through to the present, the above zone monitoring at Cranfield represents the longest continuous data series for any CO_2 injection site.

And so far, assumptions are holding up. CO_2 has remained in the confinement zone. Underground characteristics, like pressure, temperature, and water chemistry, have responded in the ways models predict. The environmental impacts of the injection have been undetectable.

Into the Future

The project at Cranfield is just one of five major projects the carbon center has conducted between 2005 and 2010. More are on the way. Awards of $11 million from state and federal agencies will be used to study the potential for CCS in submerged lands off the Texas coast. The center will receive up to $19 million to conduct a groundbreaking demonstration project in which CO_2 is captured directly from power plants, instead of from naturally occurring geologic reservoirs, and used for EOR. Another project involves assessing effectiveness of diverse monitoring programs.

Overall, the Bureau and the carbon center have received more funding to answer questions about CCS than researchers at any other academic institution in the country.

The carbon center's staff has grown from just two or three members in the 1990s to about two dozen members with expertise in geology, hydrology, chemistry, and economics—and it also includes almost 20 post docs, doctoral candidates, master's students, and undergraduate interns.

At any given time, researchers from the carbon center are working in classrooms on the university's main campus, offices at the Bureau of Economic Geology, field sites in Texas or Mississippi, national laboratories across the U.S., or presenting at conferences all over the world. In all of these places they are looking for answers that will undoubtedly steer the future of carbon sequestration. ✷

The Long (Out)Reach of the Carbon Center

"The first and last mission of the GCCC is outreach." explains Hovorka. The GCCC has long taken an aggressive approach toward sharing information with decision makers, both in industry and government at all levels, state, local, national, international, as well as the public. "In fact, all of the staff, from scientists to students, tend to be outreach enthusiasts."

And the outreach effort just got a major boost. In 2009, the Department of Energy awarded a $1 M grant to the University of Texas to educate the public as well as stakeholders about the recent advances in CCS. Called the Alliance for Sequestration Training, Outreach, Research, and Education or STORE, the program is a collaborative effort between several UT departments. Principle Investigator Hilary Olson explains "We bring together a strong basic research focus from Petroleum Geosystems Engineering and strong outreach from the Jackson School's Institute for Geophysics, and we marry that with the extraordinary applied research and field experience of the GCCC."

STORE has gotten off to a fast start, hosting field trips and workshops for professionals and education programs for K-12 students, with many more events on the horizon. In May, STORE launched its website, which along with basic information about CCS and the Alliance's activities, will include scientists' blogs and video blogs and serve as a major conduit of information for the public and stakeholders involved in carbon sequestration. (See www.storeco2now.com) This fall, several members of STORE and GCCC, including Susan Hovorka and JP Nicot, will teach a new course on carbon sequestration at UT, increasing the exposure of undergraduates and graduate students to the technology.

"What's unique about STORE's collaboration with GCCC," explains Olson, "is that we have the opportunity to launch off the Gulf Coast Carbon Center's scientific successes and transfer that technology, knowledge, and information to the public."

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ALUMNI NOTES

Future alumni of the Jackson School hiked to the top of Enchanted Rock as part of their NeoGeo orientation field trip in the fall of 2009. Freshmen attend NeoGeo before the start of their first semester to build community and get introduced to the Jackson School.

1940s

Thomas Burnett, Jr. (B.S. '49) writes, "Retired and enjoying my 8 grandchildren and great grandchildren." Thomas lives in Houston, TX and can be reached at tomjbjr@sbcglobac.net.

Thurman Geddie (B.S. '45) writes, "Still participating in drilling Oil & Gas prospects after 65 years in the business. Must be addictive as I find it difficult to stop." Thurman lives in Austin, TX and works for Geddie Oil Co., Inc. He can be reached at tgpg1@aol.com.

Ed Kennedy, Jr. (B.S. '48; M.A. '49) writes, "Mostly retired, but still keep an office." Ed lives in Midland, TX and can be reached at polkratz@apex2000.net.

G. Allan Nelson (B.S. '47) writes, "At age 88 I still work in downtown Denver five days a week. Even went out on a well this winter at age 87. Still have coffee with fellow 1947 graduate John Osmond. He and I were the only two Damyankees in a class of 33 when we graduated in 1947." Allan lives in Westminster, CO and works as a consultant.

Isaac Norman (B.S. '48) is retired and lives in Taylor, Texas.

Calvin Percy (B.S. '48) lives in Georgetown, TX.

Mary Elizabeth Sheldon Wier (B.A. '43) lives in San Antonio, TX and works for Sun Oil.

1950s

Jim Adams (B.S. '51) writes, "Got a pig valve for my heart this year. It oinks occasionally, but it beats the alternative. So we moved into Manor Park Retirement Center. It was great to visit with Bill Holland. Thank God for the West Texas Geology Society to help stay current on the latest technologies. Les White does a great job of keeping me tuned in to UT. Let me hear from you at slatsjacobs@att.net." Jim lives in Midland, TX.

Philip Braithwaite (M.A. '58) writes, "Barbara and I are still enjoying retirement in Dallas. I am doing a little part time consulting on deep water sands and Barbara is completing work on her family genealogy." Philip lives in Dallas, TX.

Leon Byerley (B.S. '52) writes, "Still going to the office, but not often." Leon lives in Midland, TX.

Jack Cartwright (B.S. '51; M.A. '55) writes, "Year 2010 marks 63 years since first enrollment at UT in 1947. 55 years since obtaining MA in 1955. 55 years of marriage to Barbara who I met 57 years ago in the Geology Library. And I will celebrate my eightieth birthday this summer. I have had a blessed life through my association from school, employment, partnerships, and self-employment. Barbara and I live in a wonderful retirement environment in Midland and are near our family. My efforts now center on managing my families assets and writing about family history. Best wishes to all my former classmates at UT." Jack lives in Midland, TX and can be reached at jccartw@sbcglobal.net.

Julius Dasch (M.A. '59) writes, "A sad note: my good friend, classmate, and field partner, Luther Wadsworth (Dan) Bridges II died in Chihuahua, Mexico while updating geology related to his U.T. PhD thesis. He died doing what he liked best, field mapping! Pat and I have been retired since 2004 and split our time between Alpine, Texas and Bridport, Dorset, UK. I teach a small amount at Sul Ross and Pat consults as an editor. I keep in touch with Phil Braithwaite, Dan Frantzen, Bill Wilbert, Dick Bennett, Bob Eaves, and Fred McDowell. I look forward to the 2010 reunion and walking by the Alphi Phi House, where I used to wait tables -- like working in a bank (: -)." Julius lives in Alpine, TX and works at Sul Ross State University. He can be reached at juliusdasch@gmail.com.

Carr Dishroon (B.A. '53) lives in Houston, TX and is retired.

Ralph Duchin (M.A. '55) writes, "Still involved in oil business to limited extent with periodic trips to Houston. Approaching 20 years in Tucson, a terrific place to live."

Fred Gibson (B.A. '51) lives in Austin, TX and is retired.

Eleanor (Ellie) Hoover (B.S. '56) writes, "BS 1956 Rec'd BS in Geology, 1956 and worked for Humble Exxon, Exxon Mobil until retirement. Still live in Conroe, Texas. Trying to keep up with new technology, unconventional oil and gas reservoirs, enhanced recovery, new horizontals, you name it. Great news and good luck to new JSG Dean Sharon Mosher and thanks to all who worked on the newsletter - good job." Eleanor lives in Conroe, TX.

Howard Kiatta (B.S. '58) writes, "Still working every day and enjoying putting oil and gas exploration projects together on the Texas Gulf Coast. We have a grandson who is a student at The Jackson School, UT." Howard lives in Houston, TX.

Sabin Marshall (B.S. '52) is retired and living in Houston, TX.

Wayne McIntosh (B.S. '56) lives in Rio Rancho, NM and is retired.

Wayne Miller (M.A. '57) writes, "Not much change since last year, just older. Continue to stay very busy consulting full time. Activity in the oil business having picked up has really affected my consulting and am working full time again: of course I seem to be a lot slower also. Family is doing fine. Due to conflict, I will be missing the upcoming Alumni Reunion next month. Hope to attend future reunions." Wayne lives in Midland, TX and works as a Consulting Geologist. He can be reached at wdmillergeol@aol.com.

George Pichel (B.S. '51) writes, "Retired 1985. Sailed the South Pacific in a 37' sailboat for 5 years - great adventure. Miss being on the Advisory Council." George lives in Oceanside, CA.

James "Jim" Richards (B.S. '56) writes, "Still consulting for Genesis Producing Company in Houston. Times are tough for selling deals because of the economy and all the funds going into resource

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.

Wear It With Pride

Jim Richards, B.S. '56 and a member of the JSG FANs board, wears his hat everywhere—Florence, Athens, Corfu, Santorini. So should you! You can find caps and other JSG merchandise via the merchandise link on our alumni pages (or just Google "Jackson School merchandise").

plays. The high oil price is helping to keep most of you in business but the BP oil spill has hurt drilling in the bays and offshore." Jim lives in Houston, TX and can be reached at jr1934@aol.com.

Edwin Robinson (B.S. '50) lives in San Marcos, CA.

Jimmie Russell (B.A. '52; M.A. '54) writes, "I will be commencing my 14th year at the GOALS Learning Center, Round Rock ISD working with special needs (Emotionally Disturbed) mid-High School students. We received numerous awards recognizing our work. It took me 2 years to settle my brother's estate. Please have your wills, etc. organized. Recently I was honored for supporting the Jackson School. I would really like to hear from you. Please keep in touch." Jimmie lives in Austin, TX and can be reached at ritalrussell@gmail.com.

Jack Sanders (B.S. '57) writes, "I would not recognize UT now. Intend to visit the Jackson School soon. Overseas work was great. Now, enjoy staying vertical and retiree travel. Population explosion and global warming remain disturbing. Our profession(s) is obligated to promote understanding and fixes for the rock on which we live. I wish for an active life for all with the UT experience." Jack lives in Dallas, TX and is retired.

George Schneider (B.S. '58) lives in Madisonville, LA and is retired.

Eugene Scott (B.S. '57) writes, "Still a Petroleum Geologist consultant in Corpus Christi, TX."

Samuel Sims (M.A. '57) writes, "All continues the same for me; still doing some consulting work for the stone industry in Southeastern Pennsylvania, although I am starting to cut back and think about packing it all in. Problem is that I still like to work. Regards to anyone who can still remember me." Samuel lives in Bethlehem, PA and works as a Consulting Geologist. He can be reached at sims1961@ptd.net.

William Slater (B.A. '50) writes, "Attempting to sell/get drilled multiple West Texas prospects using as limited leg work as possible. Leaving 'retire-

Who's In This Picture?

Going through some of her father's belongings, Becky Walker Conolly (B.A. '74) found this photo of a GEO 310 class field trip from 1949. Her father Hershel Walker (B.S. '50) died last January. On the back, some of the subjects were identified: 1. Jess Wright, 2. Dave Raul, 3. Art Tschoepe, 4. Harold Wellman, 5. Sam Levine, 6. Bruce Fields, 7. Fred Prichett, 8. Buddy Schellhase, 9. Pete Sherman, 13. Brooks, 14. Sam Terry, 15. Warren Oats, 16 Hutchinson (Instructor), 17. Bob Ross, 18. Smith, 20. "Huck" Walker, 21. Wiggin-ton, 22. Reagan Hartsfield, 23. Berny Reis, 24. Red Fry, 25. Phil Wyche. Can you help us identify any others?

Send additional info to the editors at communications@jsg.utexas.edu.

ment' to the old folks… Talk to my 35-73 whitetail deer friends about my political scene and the economy. Have already explained to them the difference between an oil spill and a blowout; THEY understand!" William lives in Canyon Lake, TX and is an Independent Geologist.

Theodore Stanzel (B.S. '56) writes, "I am spending much of my time working on Estate and Family Foundation responsibilities after dissolving the Airplane toy factory. I like the additional time to play more golf; although my drives are getting shorter, even so, the game is enjoyable. The Jackson School of Geosciences Reunion last August was a wonderful experience to attend. I want to express my satisfaction to the reunion staff for a job well done." Ted lives in Schulenburg, TX.

Robert Steer (B.A. '53) lives in Austin, TX and is retired. He can be reached at steers@austin.rr.com.

1960s

Hugh Balkwill (Ph.D. '69) lives in Radium Hot Springs, British Columbia, Canada and is retired. He can be reached at hughbalkwill@hotmail.com.

Jerry Biesel (B.A. '60) writes, "In 1959 Dr. Sam Ellison called a meeting of the Geology School students for the purpose of announcing that the outlook for graduating seniors was bleak and that there wouldn't be anyone interviewing students for jobs. I was sitting about mid-way up in the auditorium and Dr. Ellison picked me out for some reason and asked, 'Mr. Biesel, what do you plan on doing?' I was surprised at his inquiry, but, I quickly responded that I would probably sell insurance. I really didn't have any intent to sell insurance, but, I thought I should have some plan. I liked going to school so I enrolled in the UT Law School, graduated and was admitted to the Bar in 1963. I have spent the last 47 years practicing law in Dallas."

Chuck Caughey (B.S. '69; M.A. '73) writes, "Still working the Middle East, with less travel this year. It was good to see many old friends in Jakarta for a Hedberg Conference." Chuck lives in Houston, TX and works for ConocoPhillips. He can be reached at chuck.caughey@conocophillips.com.

Tom Goforth (M.A. ' 62) writes, "former W.M. Keck Foundation Professor of Geophysics at Baylor University is retired and living in Crawford, Texas."

Clabaugh's Class Convened Again

Dr. Steven E. Clabaugh and a group of former students and friends met for their annual lunch and field conference. They will gather again next year around the date of Steve's birthday. If you would like to join, call Les White at 512-301-3700 or email lesndianne@yahoo.com.

Jonathan G. Price Receives 2009 Ian Campbell Medal

Jonathan G. Price was named the 28th recipient of the Ian Campbell Medal for Superlative Service to the Geosciences. Price was presented this prestigious award at the Geological Society of America Presidential Address Ceremony in Portland, Oregon on October 17, 2009.

Price, who earned his B.A. from Lehigh University and his M.A. and Ph.D. in geology from the University of California at Berkeley, worked as a research geologist at the Jackson School's Bureau of Economic Geology. He also taught geology courses at UT Austin. Currently he serves as the state geologist and director of the Nevada Bureau of Mines and Geology at the University of Nevada, Reno, where he has worked primarily since 1998.

In addition to the Ian Campbell Medal, Price has earned many awards and distinctions including the GSA Public Service Award. Price was named a fellow of both the Geological Society of America and the Society of Economic Geologists.

He has served in several leadership roles in the geoscience community including president of the Society of Economic Geologists (2003) and the Association of American State Geologists (2000-2001).

AGI felt Price's work for the Nevada Bureau of Mines and Geology, his leadership roles within the geoscience community, and his experience in industry and academia made him extremely deserving of the Campbell Medal.

Jereld McQueen (B.S. '61; M.A. '63) writes, "Still live in Kingwood, Texas, but with a house in Marble Falls, Texas. Enjoy all the efforts and information from the JSG." Jereld is the President of Medallion Oil Company and can be reached at jemc@kingwoodcable.com.

Rubin Schultz, Jr. (B.S. '61) writes, "Beginning my 3rd year of retirement and enjoying freedom to travel (and visit grand kids). Last month (May) spent some time on Maui (HI) and just returned this month (June) from a trip to Utah to enjoy some cool mountain air. Enjoy the news from the School and looking forward to the August reunion." Rubin lives in Corpus Christi and can be reached at schultz.3331@att.net.

Robert Singer (B.S. '61) writes, "Working doing reserve engineering consulting for consulting company." Robert lives in Houston, TX.

H. Sam Travis (B.S. '60) writes, "After a short stint at doing Oil Well Electric Log Surveys of wells in Oklahoma and North Texas, I joined the Geotechnical Corporation in Garland, Texas working as a Seismologist. In 1969, I moved completely into the Computing Field working for companies such as University Computing Company, Control Data, Nortel Networks, Digital Switch, Morconi Inc. and Integrated Technology. I retired in 2004 and now manage my small portfolio of stocks, bonds and real estate investments." H.Sam lives in Desoto, TX and is the President of HST Investments. He can be reached at herbert_travis@msn.com.

Mark Valencia (M.A. '68) writes, "Aloha. I have been reitred for five years from my position as Research Fellow with the East West Center in Honolulu, an Asia-oriented state department think tank. I worked for them for 27 years. I am still consulting and participating in conferences in my field (Maritime Policy Analysis Focused on Asia) when and where I want - Malaysia, Taiwan, Vietnam this year. Otherwise, kicking back in Hawaii, play golf and cribbage, looking to buy a fishing boat and generally enjoying life with my Malaysian wife Shabariah and my married son and daughter. Aloha and cheers." Mark lives in Kaneohe, HI and can be reached at mjvalencia@hawaii.rr.com

Gerald Weber (M.A. '68) writes, "Still working as a consultant in engineering geology, but spending more time traveling - SCUBA diving in the southwest Pacific (hate the cold water in Monterey Bay), and floating rivers in the Colorado Plateau and the southwest. Other than that Sue and I are helping teach a field class in biology in Namibia each summer. Great to spend 5-6 weeks camping in the remote deserts of Southern Africa. If you get to Santa Cruz call and drop by for a cold beer." Gerald lives in Santa Cruz, CA and can be reached at jweber@pmc.ucsc.edu.

William Wilson (B.S. '60; M.A. '62) lives in Bandera, TX and works for Strata Geological Services. He can be reached at featherg@hctc.net.

Charles Workman (M.A. '61) writes, "After a 22 year career as a Navy Meteorologist, I retired and became a high school math/science teacher for 20 years. Now retired, living on the beautiful Monterey Peninsula." Charles lives in Carmel, CA and can be reached at lob2win@aol.com.

1970s

Sara Avant-Stanley (B.S. '78) lives in The Woodlands, TX and can be reached at savant@alumni.utexas.net.

Frank Cornish (M.A. '75) writes, "It's been a slow year for everyone except shale players. I'm working with LMP in

Alumni Profile:

Chuck Williamson Excelled in Oil Industry Before "Retiring"

This is one of several profiles of Jackson School alumni in the new book from The University of Texas at Austin's Graduate School celebrating 100 years of graduate education at UT Austin. The collection of alumni profiles is available from the University of Texas Press.

When he enrolled as a doctoral student at The University of Texas at Austin, Charles "Chuck" Williamson (Ph.D. '78) planned to become a geology professor. Instead, when he graduated, he went to work as a researcher for California-based oil company Unocal.

Over time, his interest in the oil industry grew far beyond the science of finding oil and gas. He became fascinated by the economics, politics and international cultures that swirl around the entire business. He took positions in England, the Netherlands and Thailand. He changed roles time after time, mastering diverse realms including operations, exploration, information technology and finance. His rise through the company culminated in his selection as CEO and chairman in 2000.

Williamson led Unocal during a watershed moment when China's offshore oil company made a much publicized bid to buy the company in 2005.

"It was a landmark," Williamson said. "It was the single biggest acquisition attempt by the Chinese at the time."

Williamson, who is now retired, lives with his wife in Sonoma, Calif. He has turned the notion of retirement on its head. He serves as director of PACCAR (the largest truck manufacturer in North America), chairman of Weyerhaeuser (a Fortune 500 forest products company) and chairman of Talisman (a Canadian oil and gas company). He consults for a biofuels company. He travels the world. He kayaks, hikes and sails. He even has his own "hobby vineyard" and makes his own wine, although he says he still has much to learn.

"I tell my friends, it's simple to make wine," he said. "It's hard to make good wine."

He and his wife both came to UT for graduate school (she studied nutrition). In his field of sedimentology, he said, UT was the first choice. Some of the world's top academics in sedimentology (including Earle McBride and Robert Folk) taught there. He says field trips and close interaction with his fellow graduate students combined with stellar faculty to make it a tremendously rewarding experience.

"I learned as much from my grad student colleagues as I did from the faculty," he said

As a student, he struggled with the uncertainties and complexities of an open-ended research project, but found the experience invaluable. He says developing the skills of a researcher, such as critical thinking, served him well in his career.

"I learned how important it is to ask the right questions, seek the critical data, dig deeper and access the resources of my colleagues and the faculty," he said. "Not a lot different from what a CEO does."

Williamson returns to campus at least twice a year as a member of the Advisory Council for the Geology Foundation, the main organ of support for advancing the geosciences at The University of Texas at Austin. As students, he and his wife loved the sense of community around the university, the live music and the food.

"I've lived all over the world, but Austin is still home for me," he said. "I always enjoy coming back." —*Marc Airhart*

CC generating south Texas 3D gas prospects, we will be ready with several deals when it comes back. We've got a retirement home in Austin. I'm working with the FANs here. We've enjoyed traveling to Hawaii and other US venues. Especially enjoyed seeing the other alums last year at the reunion and looking forward to it this year. Both Dante and Darian are employed again. Dante was married last year in Boca Raton. Trish is adjunct prof at Denton seeking full time employment elsewhere. We continue to hike around Crested Butte in summers and ski there in the winters." Frank lives in Corpus Christi, TX and is president of Imagine Resources, LLC. He can be reached at frank.cornish@gmail.com.

Russell Jackson (**B.S. '76**) writes, "Looking for oil in East Texas. Enjoyed Alumni get together at NAPE. Keep up the great work!" Russell lives in Tyler, TX and works for Tyler Oil & Gas. He can be reached at rwjtogi@suddenlinkmail.com.

David Kirchner (**B.S. '74**) writes, "David is working as a consultant in Arizona. Doing business as Basin & Range Hydrogeologists, Inc., based in Scottsdale. Lives in Phoenix with his retired geologist wife, Kathy, two sons, one is majoring in geology and geochemistry at Northern Arizona University. The other son is a senior in high school. David is on the Advisory Council of the UT Geology Foundation. His business is focused on the assessment and remediation of contaminated groundwater."

David Levin (**B.A. '78**) writes, "I humbly wish to thank all of the geology professors and staff who over many decades have dedicated their professional careers to instilling a solid geologic background for students, enabling them to pursue a career in the geologic sciences. I am still practicing my profession in oil and gas operation with joy and passion after thirty years and owe them this thanks for that blessing." David lives in San Antonio, TX and owns Power Petroleum.

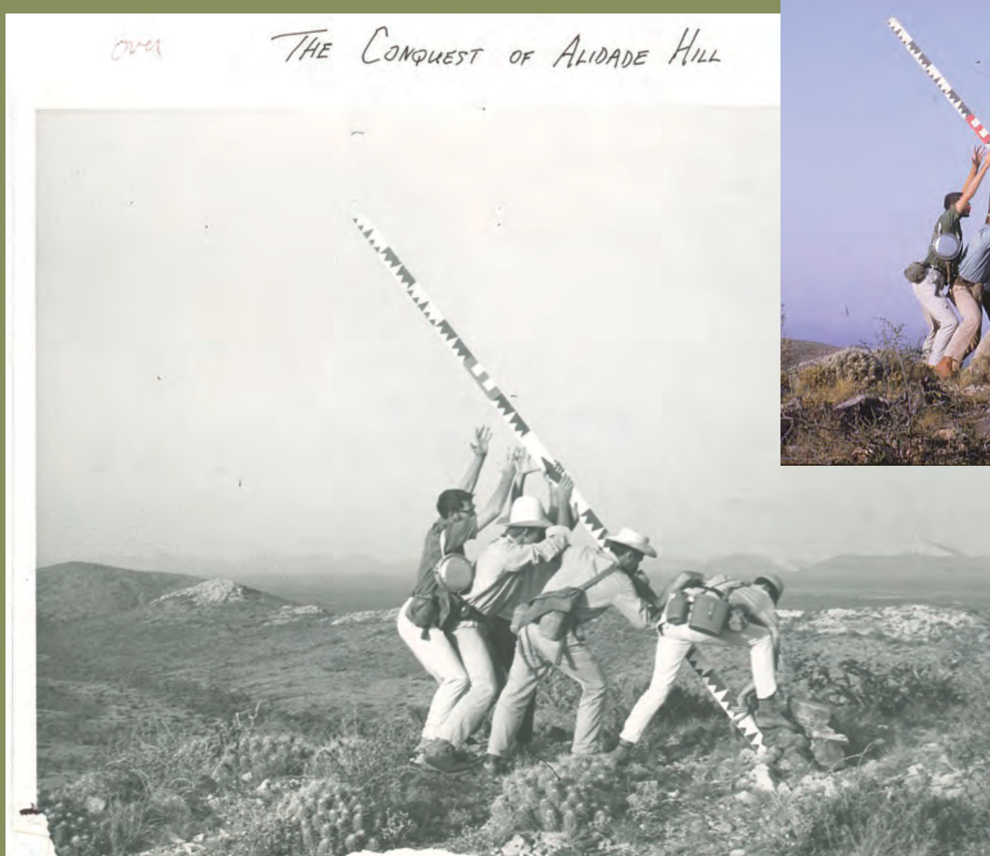
John Newcomb (M.A. '71) lives in Houston, TX and works for XTO Energy.

John Preston (B.S. '70) writes, "Still picking squiggles after all these years and stumbling into some grease every once in a while. Life is good!" John lives in Houston, TX and works for Hurd Enterprises, Ltd. He can be reached at johnwmp@hal-pc.org.

Kenneth Whaley (B.S. '76) lives in Houston, TX and works for Ryder Scott Company. He can be reached at krwhaley@comcast.com.

Who's in this Picture? We Found Out.

They say every picture tells a story. Well this one tells a few. We asked you, our faithful alumni, to help us figure out who is in this picture and what the heck is going on. Thanks to Ric Finch (Ph.D. '72) and Rod Haulenbeek (M.A. '70) for helping us recover this story from the mists of time. First, we discovered the conspirators (left to right): Haulenbeek, Rod Harwood (Ph.D. '80), Johnnie Fish (M.A. '70), and Finch. The picture was taken during a skit at a mini-Final Bedlam production at Leary Ranch in the Marathon Basin of West Texas. It took place in the summer of 1968 on a GEO 660 field camp co-taught by Sam Ellison and Earl Lovejoy (from UTEP). The course was mainly for undergraduates, but the four guys clearly visible in the photo were all grad students who had arrived without field camp experience. Finch said "we were sent out to Leary Ranch as 'remedial students.'" Haulenbeek recalled he, the other grad students, and the TA "were all in one carryall and of course had a rockin' good time (well, as good as you could have within an environment of no humidity, lechuguilla attacking your boots, rare but dangerous vipers and of course the West Texas summer heat)." Those with magnifying glasses will notice that there is actually a fifth pair of arms between Fish and Harwood. Finch speculated they might belong to Ed Berg, the TA from UTEP, but it's hard to be sure. Finch also dug up a color slide of the same scene taken at almost the same time. Haulenbeek left the geology field in 1992 and is now an amateur enthusiast on non-native landscape trees and shrubs in northwestern Nevada. Finch retired after 25 years of teaching geology at Tennessee Technological University and now lives in Cookeville, Tennessee and leads adventure/cultural tours of Latin America.



From the vault: Chock Woodruff (Ph.D. '73) looks over survey maps with Gwen Macpherson (MA '82, PhD '89). Macpherson is one of four Jackson School Ph.D. graduates on the geology faculty at Kansas University. The other three are Associate Professors Jennifer A. Roberts (Ph.D. '00), George Tsoflias (Ph.D. '99), and Anthony W. Walton (Ph.D. '72). Go KU?

Steve White (B.S. '78) writes, "I'm still enjoying living in Tyler and consulting for the oil business." Steve lives in Tyler, TX and can be reached at stevewhite-geo@gmail.com.

James Willrodt (B.S. '77) writes, "Hello to all old classmates. I am still drilling internationally and presently working in SE Asia off Borneo. Almost 33 years now with ExxonMobil with a few more to go. Karen has been doing social service work. Daughter, Erika is a sophomore at UT now and loves Austin. Son Alec is sophomore in high school here in Houston. Of late, I have been spending a lot of free time fishing out of Sargent, TX and loving it. Best to all." James lives in Houston, TX.

1980s

Janice Alsop Ver Hoeve (M.A. '82) lives in Denver, CO.

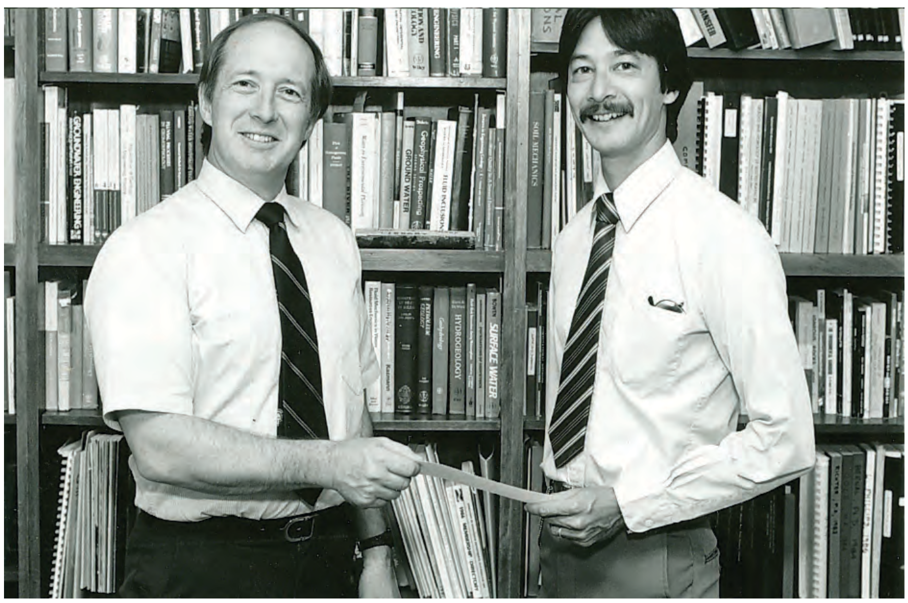
David Angstadt (M.A. '83) writes, "Still working offshore West Africa (since 1994!). I've moved from Nigeria to Chad to Equatorial Guinea to my current job in the Angola-Congo's exploration team at Chevron. I'm having the great pleasure of working with UT 1957 grad Larry Littlefied - a legend here who discovered many of the first Angola fields in the 60's and 70's." David lives in Houston, TX and works for Chevron. He can be reached at anstadt@chevron.com.

Carol Baker (B.S. '84) writes, "Rodney and I had a great time at the 1980's reunion last year. Unfortunately we'll miss this year's all alumni JSG reunion due to previous vacation plans." Carol lives in Houston, TX and works for ExxonMobil. She can be reached at rod_carol@comcast.net.

Fred Becker (B.S. '83) writes, "Plan to leave Shell ~2013 after 30 years. If you are giving overides in the GOM drop me a line." Fred lives in Houston, TX and works for Shell. He can be reached at fhbecker@sbcglobal.net.

David Chow (B.S. '85) writes, "I have been at Marathon Oil for 15 years working on Geoscience application support. We are doing a major upgrade of Landmark software this year. My daughter is studying business at the University of Houston." David lives in Houston, TX.

Michael Clark (B.A. '89) writes, "Recently just married and enjoyed honeymoon on the Hawaiian Islands (good place for honeymooners and geologists)! Went to the top of Mauna Kea which from its base on the ocean floor is the tallest mountain in the world (9,100 m). The company I work for (First American Flood Data Services) recently split into two companies and renamed themselves to Corelogic. Good for stockholders and



Frank Cornish (M.A. '75, on the right) with Professor Jack Sharp in the 1970s. Today Cornish is president of Imagine Resources, LLC in Corpus Christi, Texas.

Kim Bates, B.A. '83, was featured in a recent ad for ExxonMobil. Bates is vice president, Americas, for ExxonMobil Exploration Company.

hopefully good for business. Doing a lot of work with GIS and flood modelings." Michael lives in Georgetown, TX and can be reached at mjc@compuserve.com.

Joel Coffman (**B.S. '84**) lives in Vacaville, CA and works for US EPA Region 9. He can be reached at jcoyote1@yahoo.com.

Benjamin Davis (**B.S. '87**) lives in Alpharetta, GA.

Gretchen Gillis (**M.A. '89**) writes, "I continue to enjoy working for Schlumberger. My term as AAPG Editor ends on July 1, and I look forward to handing off to Steve Laubach." Gretchen lives in Houston, TX.

Charles Johnson (**B.S. '83**) writes, "Chasing development projects in the Gulf Coast. We seem to continue to add about two or three new fields a year. We most recently acquired Lolita Field in Jackson C. Texas. I have two kids in college, two in high school and one in kindergarten. Needless to say, I still have a long row to plow. It hardly seems I'm turning fifty, but I have been blessed to continue my work in this industry." Charles lives in Jackson, MS and works for McGowan Working Partners, Inc. He can be reached at cjohnson@mcgowanwp.com.

Jennifer Kraft (**M.A. '84**) **and Gary Donnan** (**B.A.'84**) writes, "Gary and Jennifer Kraft Donnan are still living in Houston. Gary works for Environmental Resources Management as the Director, Oil & Gas Services. He does not teach or take salsa as incorrectly stated in the last edition of the newsletter, although Jennifer thinks that sounds fun!" Gary can be reached at gary.donnan@erm.com and Jennifer can be reached at jkdonnan@earthlink.net.

Ralph Kugler (**Ph.D '87**) writes, "I joined the University of Malaya Geology Department in Kuala Lumpur in 2009 as a Principal Consultant/Senior Research Fellow for their Petroleum Geology MSC Programmes, after retiring from Schlumberger Consulting Services." Ralph lives in Kuala Lampur and can be reached at rlkugler@arenisca.com.

Thomas Layman (**M.A. '87**) lives in Edmond, OK and works for Chesapeake Energy.

Adel Moustafa (**Ph.D. '83**) lives in Cairo, Egypt working at Ain Shams University. He can be reached at armoustafa@sci.asu.edu.eg.

David Noe (**M.A. '84**) writes, "Life is good in Colorado! I manage the state's geologic mapping program. Winter finds me writing grants and publishing maps and reports. Summer brings five to six months in the field each year mapping new quadrangles. It's a dream job, a perfect balance between the city and the boonies! Best regards to Al Scott and the Dirty Dozen." David lives in Boulder, CO and works for the Colorado Geologic Survey. He can be reached at dcnoe@hotmail.com.

Terrell Rippstein (**B.S. '86**) lives in Moody, AL and works for Gallet, a Terracon Company. He can be reached at twrippstein@terracon.com.

Jerry Schwarzbach (**B.A. '83**) writes, "Loved studying geology at UT. Still practicing medicine in Tyler. My son started at UT Austin this fall."

Steve Slaten (**B.S. '82**) writes, "I am enjoying working for NASA at the Jet Propulsion Lab in Pasadena California. It is about the best job I can imagine. Bonnie works for the Aerospace Corporation in Colorado Springs, so we have made our home in Colorado, and I commute to California. Our son Sam just graduated from Colorado State with a B.S. in Mechanical Engineering." Steve lives in Colorado Springs, CO and can be reached at stevenws2002@yahoo.com.

Traci Smith (**B.S. '85**) lives in Lake Jackson, TX and works for Birdsong Real Estate. She can be reached at trackeye@swbell.net.

Burgess Stengl (**B.S. '85**) writes, "Well I think I missed the last newsletter, and I may miss the one for 2009, however, I am still in the Houston area. The family and I survived Hurrican Ike, with no real damage to the house…just nine days without electricity. It's amazing what the wind and water can do! In December 2008, Allied Waste and Republic Waste have merged, so I am now working for Republic Services at the McCarty Road Landfill Office. Angela is teaching second grade at Frank Elementary for her fourth year in the Klein School District. Our daughter Shara is teaching sixth grade in Austin, and is expecting our second grandchild. Susan graduated from UT Tyler in December 2008, and is working in the Houston area. Kyle is starting sixth grade, and is not eagerly awaiting the first day of school. I missed the class of 80's reunion las summer, but I hope everyone from

Alumni Profile: Doug Lawson, M.A. '72

Taking Flight: In 1971, a Master's Student Rewrote the Paleontology Textbooks

This is one of several profiles of Jackson School alumni in the new book from The University of Texas at Austin's Graduate School celebrating 100 years of graduate education at UT Austin. The collection of alumni profiles is available from the University of Texas Press.

Doug Lawson holds the humerus of the giant pterosaur Quetzalcoatlus northropi, *which he discovered. The name pays homage to the Aztec god Quetzalcoatl and aircraft designer Jack Northrop.*

In 1975, when Jeffrey Lawson read a front page headline in *The New York Times* on the discovery of *Quetzalcoatlus*, called the "Largest Known Creature to Have Flown," he thought of his brother, Doug, a paleontology student at UT Austin. Doug would like this article, he thought. Reading further he realized Doug already knew about it—because Doug had made the discovery.

Lawson's discovery of *Quetzalcoatlus*, one of the most amazing fossil finds of the 20th century, rewrote paleontology textbooks. *Quetzalcoatlus* was about three times larger than any pterosaur known up until that time. Today scientists recognize the gigantic proportions of many pterosaurs, including at least one larger than *Quetzalcoatlus*. But *Quetzalcoatlus* remains one of the largest flying animals of all time, and its discovery caused scientists to rethink both the evolution of flight and the habitats of the giant fliers.

Lawson made the discovery while conducting research for his master's thesis on Big Bend's paleoecology. At the time, the western part of Big Bend was not considered a likely source of dinosaur fossils. The geology was not well known. Conventional wisdom held that most or all of the Cretaceous formations in the western part of the park—rocks old enough to house dinosaur bones—had eroded away. You might find ice age mammals in the remaining sandstone, but not dinosaurs.

Aware of this and believing the geology had been misinterpreted, Lawson was scouting stream beds in the western part of the park. He was seeking specimens in sandstone formations from the late Cretaceous, the period from 145.5 to 65.5 million years ago that ended with the mass extinction of most dinosaurs.

Scanning the painted desert landscape of multicolored blue, yellow, and purple layers of soil, Lawson noticed some bones still in place about a few feet up the hillside. One bone in particular was about to be washed out of the soil.

"One more big rainstorm and it could have been eroded away," recalls Lawson.

Lawson collected the bone and some fragments. Back at the lab in Austin, he realized he had a two-foot radius—a forearm. The size of the bone meant dinosaur, but it was strangely thin, suggesting an animal that flew. Lawson started piecing together fragments. One piece with a saddle-shaped indentation was almost the size of a soccer ball. Was it part of a pterosaur joint? It was hard to say because the pterosaur specimens Lawson could consult for comparison were mainly two-dimensional, having been flattened over millennia in the compacted limestones of Kansas, where they were discovered.

Fortunately, the European fossil record had abundant, three-dimensional pterosaur specimens. They were tiny sparrow-sized animals, but despite their diminutive size, their bones and joints shared unique characteristics with Lawson's find—in particular a reciprocal saddle-shaped joint between the radius and wrist. That discovery was the Eureka moment. Lawson realized the soccer-ball-sized bone he'd found in Big Bend was the wrist of a giant pterosaur.

It would take four years from the field

discovery of *Quetzalcoatlus*, in 1971, to the publication of the results in *Science* in 1975, when the world took notice. In the interim, Lawson and his supervisor Wann Langston returned to the park to excavate more material, including a thigh bone from the original scene that cemented the discovery.

Paleontology is a science of epochs, and it's not unusual for months to elapse before a major discovery is announced. Lawson wanted to be absolutely sure before telling the world about *Quetzalcoatlus*, partly because it was so startling. The revelation of a new, massive flying pterosaur was surprising enough on its own, but Lawson's find also overturned long held notions about the geology of Big Bend and the habitat of the giant pterosaurs.

"It was pretty hard for people to accept," says Lawson. "The whole thing went against what everyone was thinking. For a guy working on his master's thesis, it was quite an exciting time."

Lawson went on to earn a Ph.D. in paleontology at the University of California at Berkeley and then to teach paleontology at Louisiana State University. In the early 1980s, he decided to switch careers, seeking more lucrative employment in the booming oil industry. It turned out his paleoecology skills were sought after. Working for Philips, Arco, and as a consultant, Lawson mapped out the ancient environments of marine invertebrates.

"To me it was mapping out the movement of habitats," says Lawson. "To the oil industry, it was reservoir characterization," a process that helps geologists locate oil and gas.

When the oil business hit its next downward cycle, Lawson's grounding in paleontology once again came to the rescue. As a professor, he had become interested in modeling artificial living systems, in part because it was challenging to gather enough data on living systems to study paleoecology. At Southwest Airlines, where Lawson found work in high-end computation, his interest in modeling living systems yielded, of all things, an application in customer service.

Airlines perennially struggle to find the most efficient means of shuttling planes, passengers, and employees through the maze of daily arrivals, departures, and delays. By creating a virtual living system, or as Lawson calls it, a "vivial model," of the airline service ecosystem, Lawson was able to help Southwest route planes to gates more efficiently.

Newspaper articles in 2007 described the solution as one based on "Swarm Theory," the idea a colony of ants works better than one alone. (In Lawson's model, each pilot acts like an ant searching for the best airport gate.) While not gaining as much media attention as *Quetzalcoatlus*, Swarm Theory nonetheless made headlines around the country. Lawson had once again made an important discovery about flight—less glamorous than *Quetzalcoatlus*, but for many people, more practical.

—J.B. Bird

Left to right: Doctoral student Jeff Nittrouer, Ryan Ewing (M.S. '04, Ph.D. '09), Benjamin Andrews (Ph.D., '09), and Philip Guerrero reunite at the 2009 AGU annual meeting.

the Class of 1985 is doing well." Burgess lives in Spring, TX and can be reached at bstengl@republicservices.com.

David Vaughn (**B.A. '84**) lives in Dallas and works for Cornet Creek Capital.

Joseph Versfelt (**B.A. '84**) writes, "I have joined Apache as a Region Exploration Manager, based in Buenos Aires, Argentina." Joseph lives in Houston, TX.

Steve Weiner (**M.A. '81**) lives in Austin, TX and works for Three Rivers Operating Company.

Susan Williams Haas (**B.S. '86**) writes, "Still enjoying the Pac NW, raising 3 children, 2 who are teenagers, and playing the harp professionally while running a private teaching studio for harp and piano students. I get outside and ride my bicycle as much as possible." Susan lives in Lake Tapps, WA and can be reached at susanwhaas1@comcast.net.

John Willrodt (**B.S. '82**) lives in San Antonio, TX and works for Valero Energy Corporation. He can be reached at john.willrodt@valero.com.

Memrie Wilson Kelly (**B.S. '85**) lives in Tomball, TX and works for Spectra Energy. She can be reached at mnkelly@spectraenergy.com.

David Worthington (**B.A. '86**) writes, "I continue to relish the challenges as a small business owner of EGA (Environmental Geotechnical Applications) Consultants, LLC. Keeping busy working mostly with soft sediment, liquefaction analysis, seismic analysis, foundation specifications for sites through Southern California. Vastly enjoying life, the outdoors, travel, Pinot Noirs, staying fit (racing bicylces) and sporting the burnt orange pride." David lives in Costa Mesa, CA and can be reached at worthy10@aol.com.

1990s

Stephen Allen (**M.A. '97**) lives in Austin, TX.

Eleanor Camann (**B.S. '99**) lives in Lakewood, CO and works at Red Rocks Community College.

Douglas Gale (**B.S. '97**) writes, "Living in Dallas and working for Union Bank as a VP in the Energy Capital Services."

Bryan Griffin (**B.S. '96**) lives in Austin, TX and works for Wild Birds Unlimited.

Glenn Klimchuk (**M.A. '93**) writes, "Became a partner in Booz & Company working in the Oil & Gas practice providing clients with strategy advisory services. Have a 2 year old son, Ike, and my wife, Christa, and I are expecting our second in June. Would love to hear from former Cloos students from that time long, long ago." Glenn lives in Houston, TX and can be reached at glenn.Klimchuk@booz.com

Lis Konnecke (**M.S. '97**) lives in Albuquerque, NM.

Cori Lambert (**B.S. '96; M.S. '00**) writes, "I've been living and working in Perth, Australia, for nearly 4 years as a geoscientist and director for my oil and gas company: Redhill Oilfield Resources. I've had tons of fun exploring this side of the world (Australia, NZ and SE Asia) - the different geology and mix of cultures of the people working the areas is fantastic and interesting. I still like to visit Texas and fill-up on breakfast tacos, Shiner Bok, live music and a wholesome dose of Americana." Cori can be reached at cori_lambert@hotmail.com.

Michelle Mallien Langthorn (**B.S. '90**) lives in Sapulpa, OK and works for Newfield Exploration as a Geophysicist. She can be reached at msmlang@yahoo.com.

Joe Reese (**Ph.D. '95**) lives in Erie, PA and works as a Professor for Edinboro University of Pennsylvania. He can be reached at jreese@edinboro.edu.

Christian Shorey (**B.S. '92**) writes, "My main work focus continues to be in Earth Science education. In order to enhance my students' education, and to reach a global audience, I have recently completed the "Earth and Environmental Systems" podcast. This work has been well received and has led to discussions with the Discovery Channel for a geology based program. I am currently working on a video podcast that will soon begin being published on the Colorado School of Mines iTunes U site early this year. Take care!" Christian lives in Golden, CO and works for the Colorado School of Mines. He can be reached at cshorey@mines.edu.

2000s

Blair Avant Francis (**B.S. '07; M.A. '09**) writes, "Blair Avant Stanley BS '07 and MS '09 married Luke Kenneth Francis, BS '07, at the Hofmann Ranch in Castroville, Texas on the 15th of August 2009. These two geologists met while attending UT for their bachelor degrees, and were surrounded by friends, family, and as many geologists as possible during their most joyous of days." Blair lives in Houston, TX and works as a geologist for BP America.

Jorge Barrios Rivera (**Ph.D. '03**) lives in Villahermos, Tabasco, Mexico and works for PEMEX.

Carrie Beveridge (**B.S. '01; M.S. '04**) lives in Vancouver, WA and is a self-employed geologist/geophysicist. She can be reached at carriebev@yahoo.com.

Ana Collins (**B.S. '08**) lives in El Paso, TX.

Elizabeth Dunn Powell (**B.S. '07; M.A. '09**) lives in Houston, TX and works as a geologist for Legends Exploration.

Josue Gallegos (**B.S. '06**) lives in Tallahassee, FL and is a graduate student in the Florida State Department of Geology. He can be reached at jjg08c@fsu.edu.

Lauren Greene (**B.S. '07**) lives in Davis, CA.

Paul Mehring (**B.S. '04; M.S. '09**) lives in Denver, CO.

Kristine Mize-Spansky (**M.S. '04**) lives in Centennial, CO and works for Encana Oil & Gas (USA) Inc.

Karen Mohr (**Ph.D '00**) lives in Bethesda, MD and works for NASA.

Petros Papazis (**B.S. '03; M.A. '05**) lives in Calgary, Alberta, Canada and works for Chevron Canada Resources. He can be reached at p.papazis@chevron.com.

Kevin Pelton (**B.S. '09**) writes, "Class 2009 - Recently hired at AGM as Quality Assurance Geoscientist." Kevin lives in San Antonio, TX and can be reached at kjpelton09@gmail.com.

Roman Pineda (**B.S. '00**) lives in San Antonio, TX and works as a Geologist for Pape-Dawson Engineers.

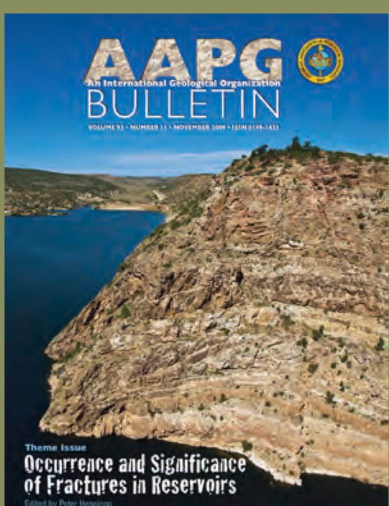
Bill Muehlberger with Dean Sharon Mosher at the August 2010 research symposium honoring Muehlberger.

Stephanie Reed (**B.S. '00**) lives in Austin, TX and works for the Railroad Commission of Texas. She can be reached at steferoni99@yahoo.com.

Jason Rush (**M.A. '01**) lives in Lawrence, KS and works as a research associate at Kansas Geologic Survey.

Jennifer Secor Harold (**M.A. '09**) lives in Austin,TX and works for Brigham Oil & Gas.

Kristina Shevory (**B.A. '03**) lives in Austin, TX and can be reached at kshevroy@yahoo.com.



Hennings Edits Special *AAPG Bulletin* on Fractures

Peter Hennings (Ph.D. '91), adjunct professor at the University of Wyoming and manager, structure and geomechanics, for ConocoPhillips Subsurface Technology, edited a special November 2009 theme issue of the *AAPG Bulletin*. The publication was dedicated to the 2008 AAPG-SPE-SEG Hedberg Research Conference on fractured reservoirs. Steve Laubach of the Bureau of Economic Geology lead-authored an article and co-authored another, and the Bureau's Christopher Zahm co-authored an article with Hennings. The issue, "Occurrence and Significance of Fractures in Reservoirs," is available online to AAPG members and readers with library access to the *Bulletin*.

Mead Turner (B.A. '07) lives in Houston, TX and works for Anadarko Petroleum Corporation. He can be reached at rmeadt2@yahoo.com.

Nataleigh Vann (B.S. '09) lives in Fort Worth, TX and works for Cawley, Gillespie & Associates. She can be reached at nataleigh.vann@gmail.com.

Jud Walker (M.A. '03) lives in Houston, TX and works for EnerVest Ltd. He can be reached at judwalker@enervest.net.

Patrick Walsh (M.A. '00) lives in Reno, NV and works for Ormat Nevada Inc. He can ben reached at walshclimb@gmail.com

Friends, Faculty, Former Faculty, and Staff

C.W. "Bill" Rogers writes, "Cynthia and I have been in Lafayette 45 years and are still enjoying it. I have a small exploration group looking for Oil & Gas along the Gulf Coast." Bill lives in Lafayette, LA and can be reached at cwr@rozel.com.

Bill Woods writes, "Francisco and I had a great trip to Central Europe this year. We flew to Budapest and spent two days there and then took a Viking River cruise up the Danube River, visiting Vienna, Melk, Passau, Regensburg, and finally Nuremberg. The cruise was a lot of fun, especially seeing the castles and beautiful churches along the way. From Nuremberg we took a bus to Prague and spent five days there. Prague is a great city to visit, with lots of places to see and good mass transportation." Bill lives in Austin, TX and can be reached at billw@mail.utexas.edu.

Scenes from the 2010 Jackson School Reunion

Find more photos from the cruise, field trip, and events on our alumni Web site at www.jsg.utexas.edu/alumni.


1940s


EXIT
Jerry
Schwarzbach

MEMORIALS

Alumni

Arthur C. Allen (B.A. '60) passed away on Sept. 4, 2009. Allen followed his long and impressive career with the National Park Service by keeping the national parks in the forefront managing a list serve that tracked the park system through news articles from across the country. He passed away in Ashveille, North Carolina at the age of 74 following a lengthy bout with lymphoma.

His career in the National Park Service began in September 1961, when he started as a GS-5 Park Ranger on the Blue Ridge Parkway at Linville Falls, North Carolina. He later worked at Big Bend National Park, Texas, in 1964 piloting a whitewater raft that took Lady Bird Johnson through the park's Santa Helena Canyon.

In 1966, Art was selected to attend the University of Michigan where he earned a master's of science degree in natural resources management. At National Park Service headquarters in Washington, DC, Art became a member of the planning teams that helped create or expand many of the country's most beloved parks.

In 1970, Art began working in Harpers Ferry, West Virginia, at the newly created Interpretive Design Center. After this, he served as chief curator of the National Park Service Division of Museum Services at the agency's Harpers Ferry Center for 12 years

Art and Peggy, his wife of 54 years, have lived in Asheville, North Carolina, since 1983. Their 54th wedding anniversary was Sept. 4. Art has three children: Son Ted (wife Belinda) and grandsons Morgan, Tyler and Brody of Buford, GA; Son Gary (wife Beverly) and granddaughter, Kerri of Wilmington, NC; and daughter Julee Gittemeier and grandson Haydn of Asheville.

Earl H. Bescher (B.S. '42), 93, passed away Sept. 19, 2009. A WW II veteran, he served as part of a field unit at Fort Sill made up of geologists called the Sound and Flash Battalion who developed methods for locating enemy gun installations using geophysics. He was a captain in the Army Air Corps. After graduating from The University of Texas at Austin with a degree in geology, Bescher worked for Humble Oil, later Exxon, for over 40 years. He became one of their most prolific recruiters. Over more than 25 years, he hired over 100 UT Austin students for Humble and Exxon. The Department of Geological Sciences honored him with a Loyal UT Alumni award at the 1976 AAPG annual meeting in New Orleans.

Bescher was a charter member of Memorial Church of Christ, serving as an Elder for many years. He is preceded in death by his wife, Sara Betty, and survived by two daughters, four grandchildren, and seven great grandchildren.


Earl Bescher (right)

Luther W. (Dan) Bridges II (M.A. '58, Ph.D. '62) of Aurora, Colorado lost his life this past October while doing geology field work in the northern mountains of Chihuahua, Mexico.

The geologist and international birder grew up in Kittery, Maine, and graduated from Harvard University in 1954. After serving two years with the U.S. Army in Germany, he enrolled in The University of Texas at Austin where he earned his M.A. in geology in 1958 and his Ph.D. in 1962. Dan worked as an exploration petroleum geologist for Shell Oil in Midland, Houston, New Orleans, and Denver. Later he established his own independent geologic consulting company, Bridges Exploration. A member of the American Association of Petroleum Geologists, the Geological Society of America, and the Rocky Mountain Association of Geologists he attended many national and international conferences giving papers and writing articles. He is the author of "Our Expanding Earth: The Ultimate Cause."

Active in politics throughout his life Dan ran (although unsuccessfully) as an Independent in 1978 for the U.S.Congress from the 5th District of Colorado on a platform for limited terms.

As a life long birder Dan traveled extensively throughout the world and participated in bird counts in remote areas of northern

Colorado. He is survived by his daughter, Anne Marie Bridges, of New York City and his brother-in-law and sister, David and Harriet Bridges Hathaway, of Lexington, Massachusetts.

Charles Anthony "Tony" Buckley (B.S. '54) of Houston passed away at home on July 19, 2010. He was born in Boulder, Colorado, on Aug. 7, 1927. He grew up in Tampico, Mexico, and attended The Kinkaid School in Houston, The Lawrenceville School in New Jersey, and The University of Texas at Austin where he was a member of Delta Kappa Epsilon Fraternity. After college, he worked in the oil and gas industry in various locations including being the head petroleum engineer of Argentina's biggest water flood project for four years before settling in Houston in the early 1970s.He is survived by Susan Frost Spice Buckley, originally of San Antonio, Texas; son, Reagan Langford Buckley of Houston; sister, Beryl Buckley Milburn of Austin, Texas; and nieces and nephews. He was preceded in death by his brothers, E. Ross Buckley, of Las Cruces, New Mexico, and Edmund Langford Buckley, Jr., of Houston.

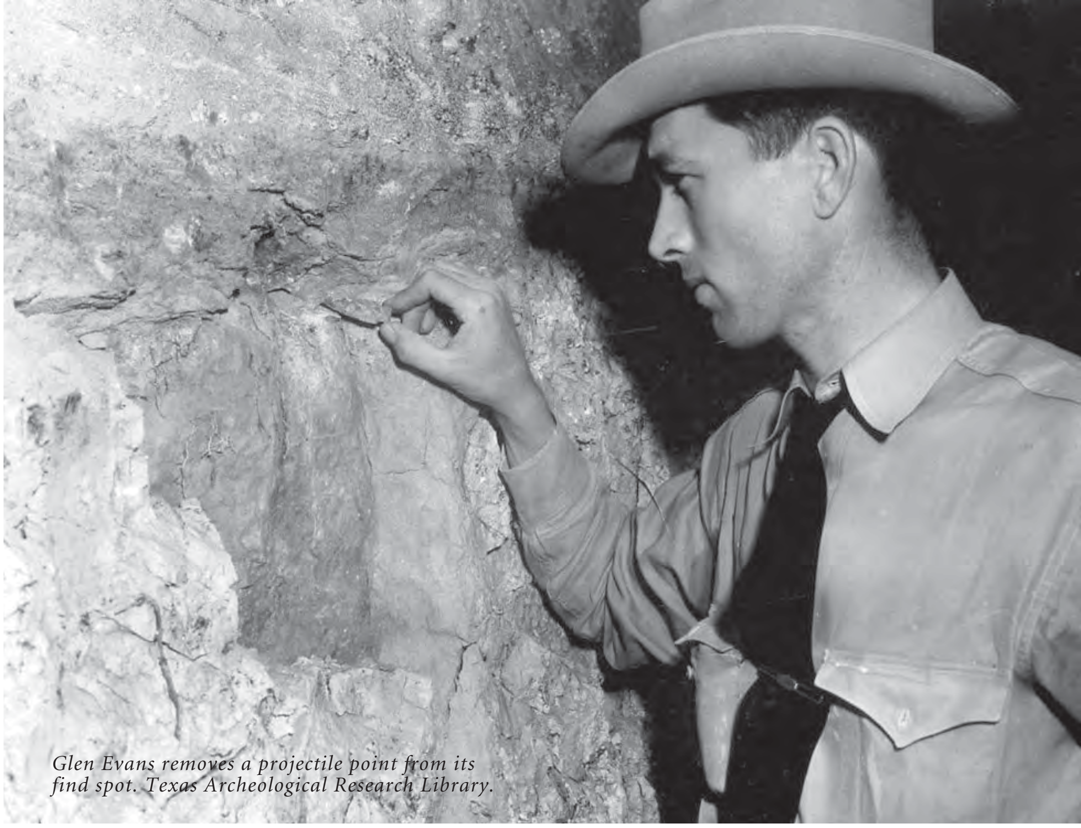
Michael B. Collins (B.A. '70), age 67 of Seguin, Texas, passed away on July 4, 2010. Michael was born on July 16, 1942 in Taft, California. He was a graduate of Seguin High School Class of 1960 and received his bachelor's degree in geology from The University of Texas at Austin. He retired from MI Drilling Fluids where he served as a geologist. He is preceded in death by his father, Msgt. Dee Collins, USAF (ret.). Survivors include his wife, Kathy Collins; mother, Frieda Collins; brother, E. Kirk Collins and wife Nina; sister, Claudia Briell and husband Bobby; nephews and niece, Andrew Ridge, Elliot Briell, Valerie Briell, Max Collins and Nik Collins.

Landon Curry (B.S. 1950), born March 24, 1927, died May 5, 2010. He was a petroleum geologist, an oil operator, and an artist. He was born in Fort Worth, Texas. He was a graduate of The University of Texas at Austin with a bachelor's of science in geology, of Corpus Christi State University with a bachelor's of arts in art, and of the Instituto Allende, San Miguel de Allende, Mexico, maestro en bellas artes. Curry was active in petroleum exploration from 1950 to 2007 and was responsible for the discovery of oil and gas in numerous fields from Hidalgo to Jackson counties in South Texas. He was a fellow in the Geological Society of America, an Emeritus member of the American Association of Petroleum Geologists, a member of the Society of Exploration Geophysicists, the American Institute of Professional Geologists, the Society of Independent Petroleum Earth Scientists, the IPAA, the South Texas Art League, the Watercolor Society of South Texas, and trustee of the Art Museum of South Texas. His art work is in collections in Norway, France, Italy, Spain, Canada, Mexico, Costa Rica and across the United States. Curry is survived by his wife of 58 years, Connie C. Curry; a son and daughter-in-law, Dr. Landon Curry Jr. and Beth Rowley; a daughter and son-in-law, Frankie and Gary E. Furman; and three grandchildren-Arthur, Lillie and Ace Furman of Austin, Texas.

Harris P. "Koop" Darcy (B.S. '51) went to be with his Lord and Savior on July 26, 2010. He was born Dec. 15, 1924, in Houston, Texas. After graduating from The University of Texas at Austin, Darcy served in the U.S. Navy as a flight instructor during World War II. Following the war he married his college sweetheart, Jane Scott Darcy, and shared 62 wonderful years with her as a loving husband, father, and friend. Darcy was an independent geologist, serving numerous oil and gas companies. He was a member of the American Association of Petroleum Geologists and the Houston Association of Professional Landmen who selected him as "Senior Landman of the Year" in 2005. He was a member of the Encouragers Sunday School Class at Second Baptist Church, Woodway Campus, Houston, Texas. Darcy is preceded in death by his parents, Mr. and Mrs. Harris B. Darcy; his daughter, Diane Darcy Ballenger; and his daughter Rebecca Suzanne Darcy. He is survived by his loving wife, Jane of Houston; his son, Scott Darcy and his wife, Pat, of Kerrville; his grandson, Chris Darcy of Kerrville; and his brother-in-law, W. Blair Scott of Portland, Texas.

Ruben Ellert (B.S. '50), 87, died July 19, 2010 of gastric cancer following a brief illness. The family requested that donations be made to the American Cancer Society in lieu of flowers. Ruben was born September 3, 1922 in Rio Grande City, Texas to Fred and Trinidad Ellert. Survivors include brothers Rodolfo Ellert and Joseph Ellert, son Leigh Ellert, step sons John Koerth and Steven Koerth and their children.

James Paul Elliott (B.S. '78), age 57, died on April 14, 2010 from pancreatic cancer after a long and determined battle. He was born and raised in Fort Worth, Texas by Charlie and Helen Elliott, who predecease him. He is survived by his wife, Cathy Kelly-Elliott; son, Jonathan Austin Elliott; stepdaughter, Zoe Stollery (Brian) and step-grandson, Hurley; brother, Bill Elliott, and a host of other family and friends, worldwide. Paul graduated from Arlington Heights High School and later attended North Texas State. His adventurous nature led him to pursue a music career in Los Angeles; however, after a life-altering experience in Colorado, he decided to pursue a career in geology. He worked diligently to put himself through school and received his bachelor's degree in geology from The University of Texas at Austin in May 1978. His career eventually led to his position as Global Product Champion of Borehole Imaging at Halliburton. He was board certified by the Texas Board of Professional Geoscientists and held memberships in AAPG, SPWLA, SPE, and HGS. In 2008, he received the H. Victor Church Award from AAPG. He loved the Earth, teaching, and his global travels, spreading his own gospel of geology and imaging to colleagues worldwide. He loved NASCAR racing, good music, and the company of family and good friends, many of them lifelong friends and co-workers. Many thanks to all who provided emotional and spiritual support to Paul and his wife during this difficult time.


Glen Evans removes a projectile point from its find spot. Texas Archeological Research Library.

MEMORIALS

Glen Evans, former student and staff geologist, collected all manner of fossils, arrowheads, crystals, and meteorites for the Texas Memorial Museum at The University of Texas at Austin in the 1940s and '50s. He was also part of a circle of intellectuals including J. Frank Dobie, Roy Bedichek, and Walter Prescott Webb who liked to spin yarns while consuming beverages stronger than water. Evans died July 14 at Buckner Villas in Austin after a hip injury. He was 99.

Ed Theriot, director of UT's Texas Natural Science Center, which includes the Memorial Museum, recalled a time that Evans, long after leaving UT's employ, visited his office. He was wearing an ascot and a confident air.

"Even in his 80s and 90s, he was an incredibly charismatic man. He just filled up a room with his personality. He had movie star presence," Theriot said. "In terms of his contributions to the museum, he was certainly seminal. His research and the items he catalogued span an incredible range, from paleontology to archaeology to geology, and this formed the core of a number of collections in those areas."

Born near Henrietta, about 100 miles northwest of Fort Worth, Evans spent his boyhood on the family farm, working livestock and fishing in the Little Wichita River. He began studying geology at UT in 1934, and although he never earned a degree, his quick mind and thirst for knowledge served him well when he took a job as a field geologist with UT's Bureau of Economic Geology.

He spent weeks at a time exploring Texas, often camping beneath the stars. He also served as assistant director and later as associate director of the Memorial Museum. His work for UT included the excavation of fossils of saber-toothed tigers at Friesenhahn Cave near San Antonio and the study of a meteor crater near Odessa. He left UT in 1953 for a position in Midland with Louisiana Land and Exploration. He rose to director of the company's minerals division.

Dorothy Newcomb , Evans' daughter, said her father often gathered in the evenings with Dobie, Bedichek, and Webb at Dobie's ranches, including Paisano, west of Austin, which now serves as a UT retreat for writers.

Evans is also survived by another daughter, Carolyn Boyd; his wife, Darla; a sister, Mary Royer of Henrietta; and four grandchildren.

Edited with permission from original obituary in the Austin American-Statesman.

Sam C. Hamilton, Jr. (M.A. '55), of Kerrville, Tex., passed away on April 18, 2010 after a short illness. His father, mother and son Mark predeceased him. He is survived by his close friend, Mary A. Sherwood of Kerrville, Tex.; his two brothers, Paul R. Hamilton of Fredericksburg, Tex., and David R. Hamilton and wife Catherine of Chicago, Illinois; son, John Hamilton of Houston, Tex.; granddaughter, Jessica Klebosky of Houston, Tex; and many cousins. Sam attended Lamar High School in Houston, Texas where he played on the 1949 State Finals football team. He attended The University of Texas at Austin where he received a master's degree in geology. Sam was a member of the Kappa Sigma Fraternity. He served in the USAF, where he was a decorated instructor pilot of advanced jet aircraft. Later he flew in the Texas Air National Guard. Sam was an enthusiastic hunter and fisherman. He engaged in the oil business and hill country ranch sales business before moving to Kerrville, Texas. He retired to a beautiful scenic residence close to his boyhood haunts along the Guadalupe River.

Jack Henry Hooper (B.A. '49) missed his 88th birthday by one day when he passed into everlasting life on May 18, 2010, surrounded by his family.

Jack, a World War II veteran and hero, proved victorious over his last battle. He was born in Normangee, Texas on May 19, 1922. He was a graduate of Kinkaid High School. Jack attended Shriner College in Kerrville before receiving his degree from The University of Texas at Austin. He enlisted in the Air Force during World War II and served in the Pacific Theatre. As a bombardier, he received for his service an Air Medal, seven Bronze Stars, American Theatre Campaign Medal, and a Victory Medal. Jack started his career as a roughneck in the tough Texas oilfields before going to work for J.S. Abercrombie Mineral Company in 1952. "Mr. Jim" Abercrombie followed by Josephine Abercrombie and presently George Robinson made it very easy for Jack to be a loyal employee. In appreciation, Jack served as an employee until the day of his passing.

He was preceded in death by his loving wife, Patricia Ann Hooper. Jack is survived by his son Michael Henry Hooper and wife, Frances; grandchildren, Melissa Ann Piper and Matthew Henry Hooper; daughter, Melinda Hooper Reed; grandson, Hunter; son, Randy Owen Hooper; grandson, Robert Tyler; and great grandchildren.

He will be sorely missed by his family, friends, his loyal hunting buddy David Smyth and the ladies at work. A member of many foundations and a generous benefactor, Jack felt that his good fortune was meant to serve those around him.

Carlton Wayne Hornbeck (B.S. '53), born July 27, 1926, passed away in his Round Rock home on July 19, 2010. He is survived by Nita Hornbeck, his children Becky Cudak of Austin, Susan and Bob Treese of Tulsa, Cyndie and Bobby Chandler of Wichita Falls and Robert Hornbeck and Gary Jones of Plano, his grandson, Eric Cudak of Austin, his sister Carla Willingham, his neice Lisa and husband, Greg Mooney, grand niece, Kimberley Mooney all of Houston, nephews Marvin and James Hornbeck. He was a founding member of the Round Rock Rotary Club, a member of the University of Texas Alumni Band, and a dedicated jogger with innumerable trophies. Although at 84 he could no longer run the Capitol 10,000, he continued his participation at the track and the Dell Diamond for many charitable events. A retired petroleum geologist, he enjoyed his friendships, especially his Tuesday Think Tank buddies, and his musical and charitable engagements. We will all miss his tender spirit and treasure our many memories of our times together. He was a loving father, brother, uncle, grandfather and an admirable human being. If you would like to make a donation to Rotary International, please do so in his memory. His family would like to thank everyone for their kindness and helpfulness during this time.

Gerhard Cyril Julius Jansen (M.A. '57), age 80, of San Clemente, California, died suddenly Feb. 23, 2010 at San Clemente Hospital following a brief illness. The family requests that in lieu of flowers donations be made to the Macular Degeneration or Alzheimer's Research Funds.

Gene Kellough (B.A. '32), aged 100, died May 30, 2010. She was married to John S. Kellough, who died in 2004, for 67 years and they are survived by their three children, Joni Grady of Central, SC, Peggy Kellough of Guangzhou, China, and Jim Kellough, Durham, NC. She also had five grandchildren and three great-grandchildren.

Gene was born Aug. 11, 1909, in Kerens, Texas. She worked for several years as a geologist in the Bureau of Economic Geology after graduating from the University of Texas in 1932. Marrying John Kellough in 1937, she made a home for him and their children wherever his work for Schlumberger took them.

In 1959 she earned her master's of science degree in geology from the University of Houston, receiving a National Science Foundation grant for her research. She was also inducted into Sigma Xi, the international honor society for scientific and engineering research.

Her hobbies after John retired from Schlumberger Well Surveying Corp. were genealogy, writing a family history that covered the first 70 years of her life, keeping up with their far-flung friends and relations, lapidary work, and reading, reading, reading. She was a member of the Unitarian Universalist Fellowship of Clemson, Honorary Matriarch of the Keowee Sailing Club, and an inspiration to her family, friends, and fellow swimmers at the Clemson-Central Recreation Center. Memorials may be made to the SC Nature Conservancy.

Quon D. Lew (B.S. '51, B.L. '60) was called back home to be with Our Lord on Dec. 24, 2009 at the age of 81. Born one of seven siblings to Chinese immigrants, he learned the value of honesty and integrity from his parents Moon and Wong Shee Lew, neighborhood grocers. His father originally immigrated to and lived in Mexico during the Revolution and Pancho Villa days, and was among the Chinese who aided the U.S. Army in different capacities. In turn it was General John "Black Jack" Pershing who escorted and helped expedite citizenship into the United States for many Chinese. After graduating from Brackenridge High School, Quon volunteered and served in the U.S. Navy during World War II, then returned to earn his B.S. in geology from The University of Texas at Austin, then his BBA from St Mary's University and finally his Doctor of Jurisprudence from the University of Texas School of Law. Never shy of work, he had been a radio operator, geophysicist, USAF security analyst, attorney, and magistrate for the City of San Antonio. Loving the outdoors, Quon enjoyed fishing, hunting, and travelling throughout the world. His other hobbies included cooking, reading, studying history, and solving crossword puzzles. By far, his true passion was following Texas Longhorn Football and he thoroughly enjoyed all four of their National Championships. He is survived by his wife of 47 years, Elsie; sons Carlton and wife Maria Elena, Bennett and wife Mandie; grandchildren Lauren, Camryn, Karis, Sean and Lillie; siblings Fing, Fing How and Kenneth. He is preceded by his parents Moon and Wong Shee; brothers Joseph, Jeffrey and George. Quon will be truly missed.

Theodore E. Longgood, Jr. (B.S. '58, M.A. Liberal Art '60), 78, of Austin, peacefully passed away on June 19, 2010. Born July 8, 1931 in Tulsa, OK , Ted proudly served his country in the United States Navy from 1951-1954 in the Korean Conflict as an Aerial Photographer. Ted graduated from The University of Texas at Austin with a master's degree in geology, where he

remained a lifetime Foundation and Texas Exes member. Ted began a distinguished, 32-year worldwide career with Exxon until his retirement in 1992. Ted married Becky Ames on April 18, 1992 in Houston, TX and soon retired to Austin in 1994 where they became longtime members of Bethany Lutheran Church. Ted enjoyed singing barbershop for over 25 years. Ted is survived by his loving wife Becky Longgood; sons Stuart Longgood and his wife Jennifer; and Bart Longgood and his wife Kristen; step-son Chris Ames; Agatha Longgood, the mother of Stuart and Bart; grandchildren Kellye, Allison, Drake, Aaron, and Brandon Longgood.

W.N. "Mac" McKinney, JR. (B.A. '60, M.A. '62), made his transition on Aug. 18, 2010, after a lengthy illness. He was born July 24, 1934, in San Antonio, TX. He is predeceased by his parents, his daughter Janan, and son Craig. He is survived by his loving wife of 18 years, Katherine McKinney; son Calvin McKinney; brothers David McKinney of Paris, TX, and Richard McKinney, of Lincoln, CA; his sister Kay, of Horseshoe Bay, TX; and numerous nieces and nephews. Mac graduated from high school in Irving, TX, in 1952, and then served in the U.S. Army in Germany for two years. Back in Texas, he earned a master's of science in geology at The University of Texas at Austin in 1962. He worked as a petroleum geologist for various companies, including Sun-Ray DX, Aminoil, Phillips Petroleum, and SONAT. After retiring in 1995, he continued to work as a consultant in this field until his death. Mac was active in many professional and community organizations. He was president of the 5,000-member Houston Geological Society and served as a delegate to the American Association of Petroleum Geologists. Mac was both an instructor for Dale Carnegie, and, for 13 years, a licensed practitioner in the Church of Religious Science. In recent years he enjoyed travelling, attending professional conventions, and making numerous trips to his favorite destination, Las Vegas, NV. Donations to the American Lung Association (2030 N Loop W, Suite 150, Houston, TX 77018) are invited.

John Marion Monk Jr. (B.A. '09), 71, of Austin died May 30, 2010. After a long absence from the university, Monk returned to complete his degree in 2009.

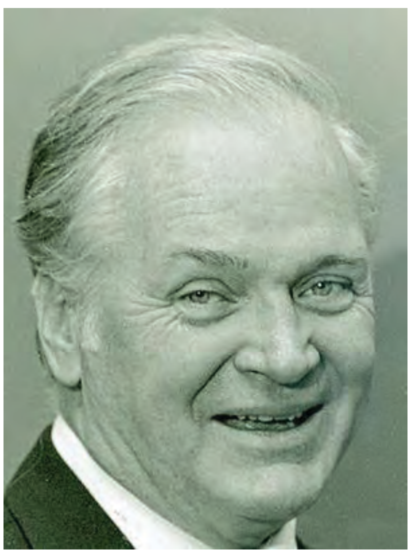
Charles Motz (B.A. Liberal Arts '49, B.S. '60), 83, passed away Dec. 29, 2009, in New Braunfels at the Christus Santa Rosa Hospital. He was born Jan. 22, 1926 in St. Louis, Mo. He married the former Marydean Walden Barron on Nov. 30, 1946 in Austin. He was preceded in death by his parents, sisters: Mary Ashby Motz Moyer, Maxwell Motz Kapus, brother, Thomas Boyd Motz, Jr., and daughter Julia Alice Motz Lehmann.

During WWII, he served with the 3rd Air Wing, U.S. Marine Corps. Motz graduated from The University of Texas at Austin with a B.A. in 1949 and a B.S. in Geology in 1960. He was employed with the U.S. Government at HQUSAFSS, ATIC and the Small Business Administration before his retirement.

He was a member of Christ Our King Anglican Church. He was a charter member and past President of William Hightower Chapter, National Society Son of the American Revolution. He was active many years with the Boy Scouts of America, earning his Wood badge. He is survived by his wife of 63 years, Marydean Motz; sons, Charles Motz IV and wife Kathy, Barron Thomas Motz and wife Michelle and William Andrew Motz; daughter, Anne Elizabeth Wood and husband Hugh; son-in-law: Jean Motz and Virginia Barron Price and husband Bruce; 15 grandchildren, three step-grandchildren, nine great-grandchildren and three nieces.

William Eugene "Bill" Murrah (B.S. '49, M.A. '50), 82, died in Ardmore, Okla. on Tuesday, Sept. 15, 2009. Bill was born Sept. 26, 1926 in Pearl, Texas. When still a baby, his parents moved to Port Arthur, Texas where he graduated valedictorian of the class of 1944. Following his high school graduation, he entered the U.S. Navy, V-12 program. A fireman 1st Class, Bill was honorably discharged in 1946. Following his service, he enrolled in The University of Texas at Austin where he received a bachelor of science degree in geology and then his master's degree in geology.

An employee of Exxon and its affiliates from 1949 through 1981, he rose to become division geologist of the Southeastern Division at New Orleans, producing coordinator of the Exploration Advisor Corporation, then division geological manager of the Southwestern Division from 1972 to 1981, living at Midland, Texas. From 1982 to 1985 he was the Eastern exploration manager for Universal Resources Corp. in Dallas. He returned to Midland in 1985 as the vice president and manager of the West Texas District Exploration Office of Valero Producing Co.



William Murrah

He and the former Betty Lois Brown were married Sept. 27, 1952 and would have celebrated their 57th anniversary this year. They enjoyed hunting, fishing, camping, and skiing. In Midland, Bill was active in the City of Midland swim team where his children swam and the family attended St. Luke's Methodist Church. In 1990 following his retirement, Bill and Betty moved to Ardmore and became active in the First United Methodist Church, the Wesley Sunday School Class, and the Emmaus Community. Bill was a member of the Geological Society, AAPG, the NRA, and the Exxon/Mobil Annuitant Club.

Survivors include his wife, Betty Brown Murrah; a daughter, Dana Murrah of Ardmore; a son, William E. Murrah II and his wife, Linda of Slidell, La; a daughter Susan Awar and her husband, Nabil of Lubbock, TX; a daughter Emily Osborned and her husband, Kevin of Buena Vista, Colo; a daughter Beth Patterson of Ardmore; and 14 grandchildren. He was preceded in his death by his parents; two infant daughters, Teresa Gae and Sandra Lee; his sister, Katherine Cowart; and son-in-law, Kenneth Patterson.

Gail E. Oliphant (B.S. '53), 79, went home to his Lord and Savior on Oct. 24, 2009. A Native Houstonian, Gail was born on July 9, 1930. Preceded in death by his son Keith, he is survived by his beloved wife Marty and devoted daughter Karen, both of Houston, two sister-in-laws, Mary Epps and Beverly Oliphant, and two nieces and one nephew. His mother, father, and brother Bill Oliphant also preceded him in death. He served as a Sunday school teacher for 25 years at First Baptist. Humble Oil/Exxon employed him for 23 years before he formed a partnership, Quattro Exploration, with dear friends. He was national president and Houston chapter president of SIPES from

1985-1986. Throughout his adult years, he served as a deacon, training union leader, a Sunday school superintendent, and an avid Bible teacher for 45 years. Gail was a loving, devoted father and husband and is remembered as a pleasant, friendly, witty, and caring man.

Donald F. Reaser (Ph.D. '74), age 78, died Dec. 29, 2009. Born Sept. 30, 1931, in Wichita Falls, he was professor emeritus of geology at the University of Texas at Arlington where he taught for more than 40 years. Don received his Ph.D. from The University of Texas at Austin, and he held B.A. and M.S. degrees in geology from SMU where he was a member of Lambda Chi Alpha fraternity. He was a graduate of Highland Park High School and served in the U.S. Air Force.

He was a certified professional geologist of the American Institute of Professional Geologists and a registered professional geoscientist with the Texas Board of Professional Geoscientists. He was a 32nd-degree member of the Masonic Lodge.

Don was preceded in death by his parents, Norene Wales and Fred S. Reaser. Survivors: His wife, Bette Forrest Reaser of Waxahachie; sister-in-law, Dell F. Andrews of Waxahachie; stepson, David Forrest Anderson of Richmond; cousins, James F. Strong of Point Venture, Robert Wales of Melissa and Marita Wagner of Midland; and nephews, John F. Andrews of New York,, N.Y., Jeff Andrews of Dallas and Bill Borders of Aurora, Ill.

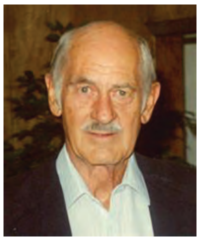
M. Allen Reagan (B.A. '50), age 83, passed away May 7, 2010 in Houston. He was born July 20, 1926 in Waco, TX. He served in the U.S. Navy on the U.S.S. Chesapeake, and graduated from The University of Texas at Austin, where he was a member of Lambda Chi Alpha Fraternity. He then moved to Houston in 1952 as a geologist with Brazos Oil & Gas and later Dow Chemical Company. He moved to Dow's headquarters in Midland, Michigan in 1965 and returned to Houston in 1969 as senior vice president for Houston Natural Gas and later Mosbacher Energy. He then joined Seagull Energy Company, serving as chairman of the board until his retirement. He was an early and longtime member of Chaplewood Methodist Church prior to joining St. Luke's Methodist Church, and a member of Bayou Club of Houston. Allen was an avid reader, hunter, gourmet cook, and world traveler. Friends and family were of paramount importance in his life. He was preceded in death by his parents and his wives, Martha Riley Reagan and Sue Ann Thomas Reagan. He is survived by his wife, Doris Anderson Reagan, and her children and grandsons; his sisters, June Reagan Dietrich and Ruth Reagan; and by his daughter, Deborah Reagan Swearingen and husband Paul; his son, Berkley Reagan and wife Julie; his grandchildren, great grandchildren, step children, step grandchildren, and nieces and nephews.

Walter Staehely Jr. (B.S. '42), age 90, died Sept. 1, 2009. He was a native Austinite. Walter was preceded in death by his parents, Walter and Alberta Staehely, and six siblings, Mary Lucille Riley, Sophie Cooke, Alfred Staehely, Carolyn Grove, Anne Sundstrom and Martin Staehely. He is survived by his dear brother, William Staehely. Walter graduated from Austin High School in 1937 and went on to get his degree in geology at The University of Texas at Austin and later attended graduate school there. He served in the United States Army Air Forces during World War II and later in the Reserve Corps where he achieved the rank of Captain. Walter worked briefly as a geologist and later for the Civil Service as personnel management specialist. Upon his retirement, Walter went on to become an accomplished artist in many different types of mediums. He enjoyed studying and raising birds, traveled extensively, and was a great resource on Austin history. Walter was a devoted son, brother, and uncle. His gentle southern manners, dry wit, and twinkling eyes were his hallmark. He is in our hearts and will be missed by many.

Jack W. Stearman (B.S. '58) passed away at the age of 86 on May 7, 2010. Jack was born in Wichita, Kansas, on July 14, 1923. He was a veteran of World War II specializing in radar repair and navigation. He later obtained his private pilot's license and was a member of the Civil Air Patrol. He attended The University of Texas at Austin graduating with a degree in geology with interests in petroleum engineering and subsurface hydrology. Jack was a lifetime member of the Texas Exes Association and supported the university with a passion. He was a member of the Austin Geological Society, the Association of Engineering Geologists, and the American Institute of Professional Geologists. He retired from the Texas Water Development Board after 30 years ultimately rising through the ranks to become section chief for the Economics Groundwater Usage Division. Jack was a strong believer in service to the community. He was an active member and one of the founders of the University Christian Church. Having achieved the rank of Eagle, Jack was an avid supporter of the Boy Scouts throughout his life. He helped found the Balcones Little League and served as its first president. After retirement he continued to engage life. He joined a square-dance club, tried his hand at golf, joined the Men's Garden Club, and bought a travel trailer to explore much of the beauty Texas has to offer. Jack was a member of the Austin Czech Historical Society and the American Legion Post 76. To all who remember him, his legacy will be his kindness, unselfish generosity, and steadfast belief in doing the right thing. He is survived by his loving wife Helen G. Stearman; two sons, Jim and Alan Stearman; his brothers, Don Stearman of Dallas and Joe Patton of Fort Worth.

Nelson E. "Web" Webernick (M.A. '52), of Midland, Texas, passed away May 10, 2010. He was born July 14, 1922 to Horace and Rosa Webernick. After graduating from Ganado High School, he attended Texas Lutheran College. He served in the United States Marine Corps in WWII, in the Asiatic-Pacific, China Occupation, and American Theatre. He graduated from Southwestern University with a Bachelor of Science degree in geology. He then received a master's degree in geology from The University of Texas at Austin. He served as an assistant professor of geology at Southwestern University and was then recalled into the Marine Corps during the Korean Conflict.

He attained the rank of captain in the Marine Corps. Web worked for Marathon Oil Company from 1952 to 1976 as a petroleum geologist and exploration manager. In 1976 he began his career as an independent



petroleum geologist and was associated for some time with Richard Gaddy, Jack Russell, "Buzz" Mills, and Robert Johnston. He was a member of the West Texas Geological Society, American Association of Petroleum Geologists, and Texas Board of Professional Geoscientists. Web was preceded in death by his parents and two brothers. He is survived by his former wife, Gloria Webernick of Georgetown; his wife, Peggy; son and daughter-in-law, Jack and Rebecca Webernick of Georgetown; son and daughter-in-law, Gary and Lana Webernick of Austin; son and daughter-in-law, Mark and Jean Webernick of Las Vegas; three grandchildren, Jessica, Mason, and Billy; and two great-grandchildren, Lyla Jean and Landon.

August W. Walla (B.S. '49) was born on Oct. 11, 1926 and passed away on Saturday, July 17, 2010. August was last known to be living in Tulsa, Oklahoma. He received his bachelor's degree from The University of Texas at Austin. Walla served in the United States Army during World War II. A memorial service was held July 20, 2010, at the Mason Chapel of Asbury United Methodist Church.

Thomas C. Woodward (Ph.D. '55) passed away quietly April 25, 2010 after suffering for several years from dementia with Lewy bodies. Tom was born in Wilmington, Delaware on May 10, 1925. He grew up in Wilmington, graduating from Tower Hill School with the class of 1943.

Tom started at Williams College in 1943, then went on active duty with the Navy, where he graduated from Midshipman's School in the fall of 1944. He was commissioned Ensign U.S.N.R. in Feb. 1945, did sea duty on light cruiser U.S.S. Fargo, then was Gunnery Officer on destroyer escort U.S. Kleinschmit. He was discharged from the Navy in August 1945. Returning to Williams College, Tom completed a B.S. in physics in 1947, and in 1950, he graduated from Colorado School of Mines with an M.S. in geophysics. In February 1954, Tom married Lucy Liddle in Cincinnati, Ohio, then took her with him to Wyoming, where he was doing geological field mapping as part of his work on a Ph.D. in geology, which he received in 1955 from The University of Texas at Austin.

Tom and Lucy settled in Casper, Wyoming, where they lived for 53 years, until moving to Butte, Montana in May 2007. While in Casper, Tom worked for Gulf Oil and Amoco Oil, then became a named partner in a geology firm with offices in Casper and Denver, Colo. He later became an independent geologist, working in oil and gas, coal, uranium and trona exploration, as well as on coalbed methane gas. He was a member of The American Association of Petroleum Geologists and the Wyoming Board of Professional Geologists. For years, Tom was a certified instructor for the Dale Carnegie Course.

Tom learned to downhill ski at age 45, packing Lucy and their three children off to nearby ski areas each weekend. It turned into a delightful family focus, resulting in many ski trips to Colorado and Utah as well. Tom and Lucy also learned to scuba dive and got certified in 1981, leading to more travels, including trips to Hawaii, Greece, the Caribbean, Mexico, Honduras, The Galapagos Islands, Egypt, and the Red Sea.

Tom had a love of language and worked on improving his vocabulary. Even with his illness, which limited his speech, he was still able to say one-liners, and he charmed the many nurses and aides who took care of him. Tom had a way about him that made people feel at ease, and he made many friends. He will be greatly missed.

Tom was preceded in death by his parents, sister Mary Ellen Maroney and brother-in-law Hal Liddle. Tom is survived by his wife, Lucy; daughter Lynn (Steve) Tarrant; sons, Tom (Marta) Woodward of Grass Valley, Calif.; James (Laurita) Woodward of Guadalajara, Mexico; sister Anne Clancy; several nieces and nephews; and 15 grandchildren.

Faculty, Staff & Friends

Evans, Glen—See entry under alumni.

Neil Eugene Hanson passed away peacefully on the Dec. 2, 2009 at home surrounded by his family after a courageous battle with cancer.

Neil was born at home on Oct. 2, 1931 in Houston, Texas. He graduated in 1949 from St. Thomas High School. Shortly after that he met the love of his life, Barbara, whom he married in 1951. Neil continued his education at the University of Houston and received his geology degree in 1953. With two children in tow, Barbara and Neil moved to Corpus Christi where he worked for Union Sulphur Company. In 1957, thankfully he was transferred back to Houston where he joined George Mitchell's oil company. In 1958, he went to work for M.P.S. Production Co. as their only in-house geologist. After two more children were born, Neil took the big gamble of going out on his own as an independent oil operator. His intuition and tireless efforts eventually built one of the strongest independent exploration companies in the industry, Hanson Minerals Company. His company and family continued to grow with the birth of another son. Neil's business expanded into the drilling industry with his company, Southland Drilling Company. Right up until he passed away, he received daily drilling reports, lob analysis, and farm and ranch reports every morning.

Neil played just as hard as he worked and his two great loves, aside from his family, were his ranch and his boats. He owned numerous power boats throughout the years, all appropriately named the "Wildcat." He and Barbara loved to entertain family and friends aboard the Wildcat and some of his greatest days were spent on the water. He traveled the entire Gulf Coast, the Atlantic Seaboard, and much of the Bahamas. His equally favorite place was at his ranch in Nordheim, Texas, especially at Thanksgiving and Easter surrounded by his family. He loved driving the grandkids around looking for deer or hogs, burning a big fire at Neil's Sunset Bar & Grille, and simply enjoying his family. Neil treasured his Catholic education and made sure all of his children received one as well.

He was extremely generous to numerous Catholic charities and schools throughout Houston and Texas. His generosity was not limited to Catholic causes alone as he was always ready to help out anyone who asked him, from buying a new transmission for his yardman, donating a school library, or building a baptismal font.

Neil was a member of AAPG, IPAA, TIPRO, and numerous other professional organizations and in 1989 he was selected to membership in the All American Wildcatters, whose creed is "My Word is My Bond." Neil lived by that creed his entire life.

Neil is survived by his soul-mate and best friend, Barbara; his sons, Chris Hanson, Erik Hanson and wife Lisa, Kurt Hanson and wife Susan, and his much loved only daughter Tina and husband Ben McCarthy; and numerous grandchildren, great grandchildren, nieces, nephews and cousins.

Jerry W. Mullican, former research fellow at the Bureau of Economic Geology, died at the age of 74 on April 29, 2010 surrounded by his loving family. Born in Wink, Texas, on April 12, 1936, Jerry graduated from Snyder High School, later meeting and marrying Sharon Skrabanek in 1957. With dedication from both Jerry and Sharon, he graduated from West Texas State in 1963. Working for Dowell, and later as Texas parks superintendent for Palo Duro Canyon, Jerry decided he wanted to further his education, moving his family back to Lubbock to pursue a master's degree in geology. This decision offered the opportunity to move to Austin, once again working for the State of Texas. Jerry's positions included: The Texas Water Quality Board, chief of geological services (1969-1977); Texas Department of Water Resources, chief of solid waste and underground injection (1977-1980); Railroad Commission of Texas (RRC)/Oil and Gas Division, assistant divisions director and legal enforcement (1980-1995).

He worked at the Bureau of Economic Geology (BEG) as a research fellow in the environmental group from October 1995 to February 2003.

"While at the RRC, Jerry was always a very big supporter of the BEG and Dr. [Bill] Fisher," writes his nephew Bill Mullican. "So when he was appointed as a research fellow, he took on this new opportunity with all of the excitement and energy one normally equates with someone's first job. While at the BEG, Jerry was an important liaison with the Department of Energy, Environmental Protection Agency, and the American Petroleum Institute, in the development of major projects."

Jerry was also a member of the following organizations: Environmental Affairs Committee, Ground Water Protection Council, Society of Petroleum Engineers. He also served as president of Ground Water Protection Research.

A few of his recognitions and awards include: The Texas Railroad Commission Outstanding Service Award (1988); Federal Advisory Committee to EPA on Class II injection wells (1993); and Board of Directors of Ground Water Protection Service Award (1995).

Family, friends, and the State of Texas were the true loves of Jerry, to which he dedicated his life. Jerry is survived by Sharon, his wife of 53 years; son Scott Mullican; daughter Tracy Wilson; two grandsons, Randy Wilson and Daniel Wilson; sister, Marge Hood, and her husband Bill of Dallas; three brothers, Frank Mullican Jr. and his wife Doris, Lee Mullican and his wife Jean of Oklahoma City, Larry Mullican and his wife Betty of Lubbock; his special companion Sophie, a miniature schnauzer who was also part of Jerry's circle of family laying by his side in Vista Care. He is also loved by many nieces and nephews, a family totaling over 55.

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The staff and members of the Jackson School of Geosciences would like to convey our respect to the families of the following alumni:

Gordon E. Adams (B.S. '55, M.A. '57)
Dick Eric Atchison (B.A. '53, M.A. '54)
Clyde Andrew Brooke (B.A. '46)
Melvin Richard Dixon (B.S. '59)
William Dixon (M.A. '58)
Daniel Droll (B.S. '49)
Dragos Dzac (B.A. '95)
Billy Joe Hinson (B.S. '50)
Richard King Redfearn (B.S. '58)
Paul E. Schnurr (M.A. '55)
John Tuohy (B.S. '39)
Hershel Walker (B.S. '50)
Clyde E. Williams (B.S. '56)
Dan W. Williams (B.S. '56)

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Contributions are tax deductible and may be mailed to the Development Office, Jackson School of Geosciences, 1 University Station; C1160, Austin, Texas 78712-0254. Please make checks payable to The University of Texas at Austin. Stocks and bonds may also be assigned to The University of Texas at Austin. For your convenience, a postage-paid envelope is inserted with this edition of the *Newsletter*.

You may make your donation by completing and returning this form with your gift in the envelope provided. If your employer matches charitable gifts, please obtain the form from your human resources department and enclose it with your contribution. Donors of gifts of $10,000 or more (including cumulative matching gifts) are recognized as members of the Hill Society. Our goal is to raise JSG alumni giving participation to 20 percent, so every gift counts. *P.S. Whether or not you send a contribution, you can use the back of this form to submit alumni news for the next newsletter—please stay in touch!*

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2010 Jackson School of Geosciences Alumni News Update/Submission Form

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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.

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