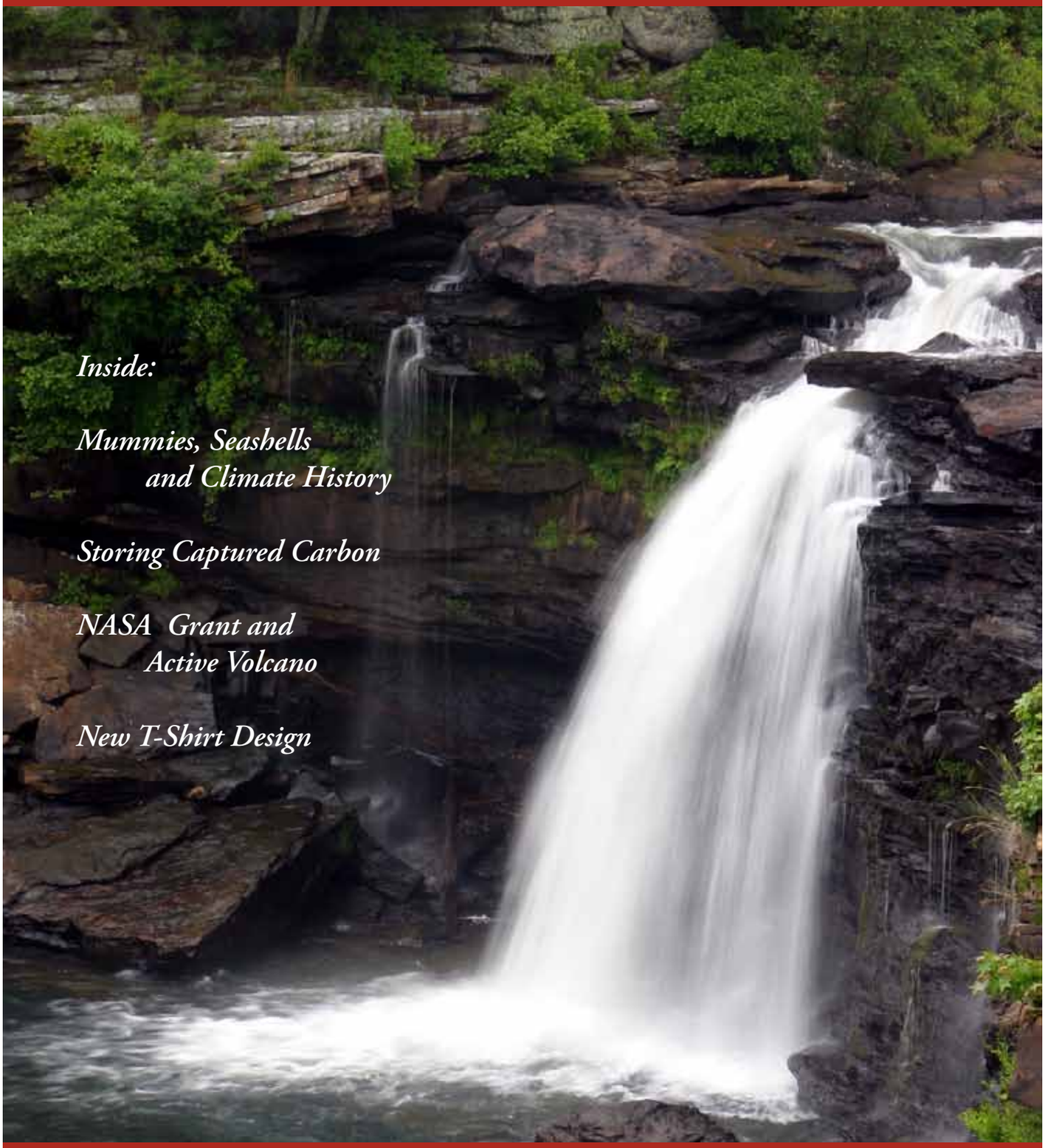
# Crimson Tide GeoNews

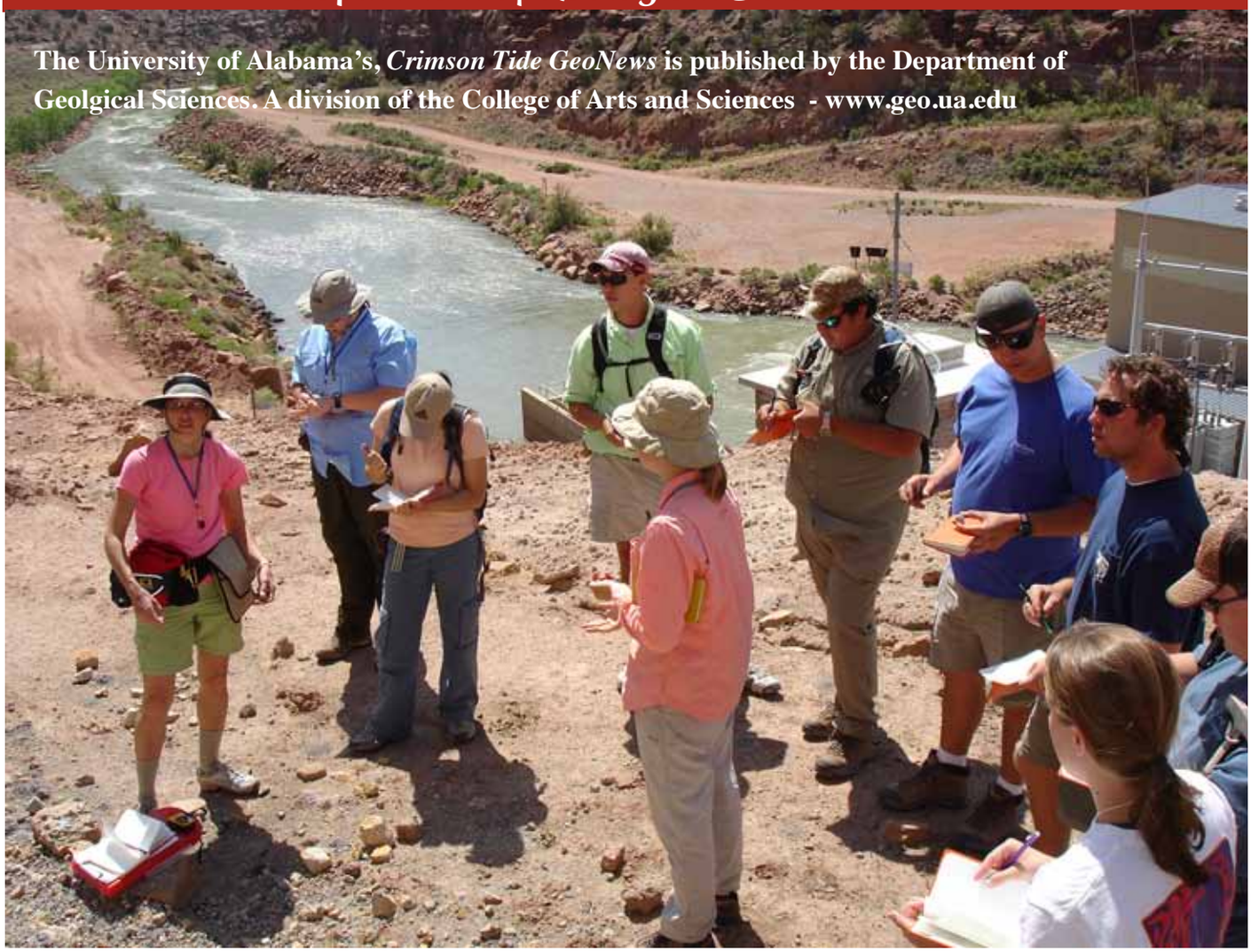
2011 Volume 2



*Inside:*



**Department of Geological Sciences** **The University of Alabama**



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COVER PHOTO
"Water, one of Alabama's precious natural resources, enters the Little River Canyon as it flows over the cross bedded sandstone of Little River Falls." Photo by Joe Lambert

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# Note from the Chair

Dear Friends,

Once again another eventful year has come and gone from our lives in what seems like no time at all. In my second year as DGS Chair, my family and I are feeling more at home in Tuscaloosa and we are big Tide fans. Roll Tide!

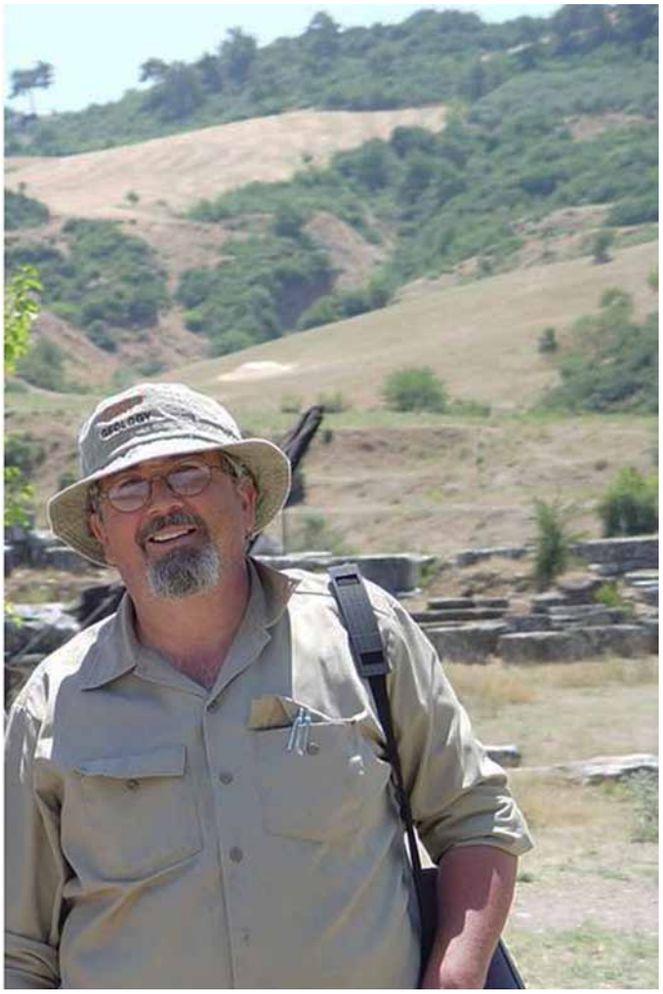
Since the first issue of the DGS Crimson Tide GeoNews in Spring, 2010, a number of important changes have taken place in the department. There are many achievements by our students and faculty to report. Some of these have been reported in this issue of the GeoNews. However, if we try to report every achievement, we would have to write a newsletter at least 10 times bigger than the present issue.

The Department has continued to grow in a very healthy way. In Spring, 2011, DGS has 72 undergraduate students and 49 graduate students. We have 13 full time and 1 part time faculty. Last year, we hired two new faculty members. Dr. Samantha Hansen joined us as our new Seismologist and Dr. Yuehan Lue joined us as our new Molecular Geochemist. They both had a strong start in their first year and have been very busy with their research and teaching. Please see inside for more about Samantha and Yuehan and about their research interests. In spring, 2011, we are interviewing for two tenure track positions, a Radiogenic Isotope Geologist, and a Sedimentologist. Additionally, we are interviewing for a three-year temporary hydrogeologist position. These three searches are continuing as I write this message. In spring 2012, I hope to report to you about the new faculty in these three positions.

Our Department has been through an assessment program review. The DGS assessment committee successfully completed the review report which indicates that we are in very good shape. Consequently, Dean Olin asked DGS to start preparing a new 5-year Departmental Vision plan due in May 2011. Our short-term goal is to reach 17 full time faculty by Fall, 2012 and our long-term goal is to reach 20 faculty by Fall 2017.

Our faculty continues to be very active in research and teaching. They were awarded over $2.1 million in research grants and contracts. Please see inside for summaries of some of our major research projects, such Carbon sequestration, NASA volcano prediction, Paleoclimate in south America, and BP Golf of Mexico cleanup project. Through their research projects, our faculty produces and publishes new knowledge and interpretations. During the last academic year, they have published 1 book, 33 referred journal articles, 2 referred book chapters, 5 Technical reports and 54 refereed abstracts.

In terms of teaching, the DGS faculty produced a total of 10,108 student credit hours with teaching undergraduate and graduate courses to the UA students, graduated 21 undergraduate students, and 7 graduate students. Many of these students have already accepted jobs in geological industry and are on their way becoming contributing alumni of the UA Department of Geological Sciences.



*Çemen in field in Western Anatolia, Turkey*

The UA Arts and Sciences College has been very supportive of our programs in the past and continues to help. For example, this year we have 21 Graduate Teaching Assistants working in the department. We hope to have 22 GTA in fall 2011. The continued support of the college, combined with the support we have received from alumni, will enable us to continue to excel to be the best department we can be.

However, we still have a long way to go in our pursuit of excel-

lence and we need your help. Scholarship support for undergraduate and graduate students is always needed to help attract and keep talented students in the department. The Geological Sciences Advisory Board has long recognized this need and has provided over $80,000.00 for scholarships since the initiation of the board in 2002. The Board has set up a $10,000 endowed fund for the DGS Field Camp.

The spring 2011 GSAB meeting was held during the AAPG Annual Convention in Houston on April 12, 2011 from 1:30 to 4:30 p.m. at the Downtown Club at the Houston Center. It was well attended by the board members. Following the meeting, the UA College of Arts and Sciences Alumni Reception was held in the same area from 5:30 to 7:30 p.m. It ws an excellent opportunity to see what the Department of Geological Sciences had been working on as well as an opportunity to see some old friends and classmates. We will have our Annual Homecoming Alumni Barbeque in the evening of October 7. The 2011 homecoming game verses Vanderbilt is on October 8, 2011.

As I pointed out in the DGS 2010 GeoNews, one of our pressing needs is financial support to augment stipends for our Graduate Teaching Assistantships (GTAs) who work very hard. Our GTAs teach three lab sections in comparison to two lab sections in most Ph.D. granting departments. We established an Academic Excellence Scholarship (AES) of $3,000 for qualified first year M.S and Ph. D students to be added to their regular GTA. We awarded three AES awards for the 2011-2012 academic year. The total GTA- AES package is now $17,229 which is comparable to many GTA stipends in the SEC although it is still less than many major Ph.D. granting Geological Sciences Departments in the country. We are hoping to find new ways to increase our GTA stipend amount substantially in the years to come. Better monetary offers should help us to attract high quality, talented graduate students.

We are also working to reduce teaching load of faculty and Graduate Teaching Assistants. The reduced teaching load would help our students spend more time on their M.S. thesis and Ph.D. dissertation projects and finish in timelier manner . It will also help our faculty to spend more time with their students, and produce more new knowledge in research. We have recently given one-course per year release to the DGS graduate and undergraduate faculty advisors. This will help them to spend more time to recruit high-quality undergraduate and graduate students to our department.

Last year did not pass without sad news. On April 2, 2010, we were deeply saddened by the lost of one of the legends in the history of the UA Department of Geological Sciences. On that day, Dr. Douglas Jones passed away. He will always be remembered by the faculty and students in the Department.

During the Spring, 2010 meeting, the GSAB decided to accumulate their fund raising efforts in an endowment fund called the GSAB Doug Jones Scholarship fund. The fund aims to reach $250,000 by December 2012. When completed, this fund will provide much needed endowment for undergraduate and graduate scholarship. The recipients will be named Doug Jones Scholars. If you wish to contribute please contact Darlene Capps at dcapps@as.ua.edu or Rebecca Florence at rflorenc@as.ua.edu

I hope you are proud to be a part of the University of Alabama, Department of Geological Sciences. Our goal is to become a better recognized Geological Sciences Department in the U.S. and in the world. DGS is thriving towards this goal. This is certainly an achievable goal with the talented and hard working faculty and students we have in our department. With your help and involvement, we will achieve this goal earlier and even better than we could imagine. I would be happy to hear if you have any suggestions for improving the Department and its programs. When you are in Tuscaloosa or in a nearby community, please stop by and see us, we will be glad to show you the changes taking place in the Department.

With my best wishes,
I. Çemen

I. Çemen

Chair & Professor

# Remembering Dr. Jones

Dr. Douglas E. Jones, a longtime vital part and supporter of the Department of Geological Sciences, died on April 2, 2010. He began his professional career as an Assistant Professor of Geology at The University of Alabama in 1958. For 38 years he served the University in many sequential roles including Professor of Geology, Chairman of the Department of Geology and Geography, Dean of the College of Arts and Sciences, Dean of the University Libraries, Vice President of Academic Affairs, and Executive Director of the University of Alabama Museums. The museums included the Alabama Museum of Natural History, Moundville Archaeological Park, and The Paul W. Bryant Museum.

After his retirement in 1996, he continued his association with paleontology at the Museum of Natural History. He was also one of the founding members of the Advisory Board for The Department of Geological Sciences. His spirit and accomplishments will forever live within the Department, setting an example for students and faculty alike.

# Mummies, Seashells and Climate History

Written By Chris Bryan / Photos by Samantha Hernandez

Shells from mollusks presented to the dead during ancient funeral ceremonies are keys to helping a University of Alabama geologist gauge ocean movements near the Peruvian coast from as much as 13,000 years ago. No, really.

These unlikely sources serve almost as historical calendars filled with data about the conditions of the portions of the ocean in which they lived – conditions which may well have been vital to the well being of ancient Peruvian cultures, including the Moche, according to Dr. Fred Andrus, an assistant professor in UA's geological sciences department.

Andrus and colleagues at the University of Arizona and the University of Maine, were awarded a $600,000 National Science Foundation grant to develop a better understanding of a deep ocean phenomenon known as upwelling and its impact on the climate and the economy of the people who lived in Peru over the past 13,000 years.

The work revolves around radiocarbon dating of the shells, but draws from anthropology, archaeology, chemistry, forensics and geology. It's providing insight into climate history and a key contributor to that history, El Niño events, as well as, perhaps, significant developments in culture shifts that may have resulted from those long ago climate changes.

In 2002, Andrus co-authored a paper publishing in Science describing a change in El Niño-related ocean temperatures 5,000 years ago. The research suggested the climate shift may have contributed to increased economic complexities among cultures. Suggesting the one led to the other was, and is, a contentious idea, Andrus says.

"What does seem to be pretty well accepted is that you had a major change in El Niño about five-to-six thousand years ago, and then you had this huge fluorescence in civilization," Andrus says. "The question has long been, is that just a coincidence, or is it linked? My mind was drawn to see if changes in upwelling changed coastal production (related to fishing) because those things can be directly linked to El Niño."

## A Global chain Reaction

Upwelling is the wind-driven act that brings deep water back to the ocean's surface. As the ocean's deeper waters contain more nitrogen and phosphorous, more marine life lives in the upwelled water. So, deep water upwelling off Peru's coast makes fishing more plentiful, except when it doesn't occur during El Niño events.

Upwelling is part of the El Niño cycle, but the interaction is complex.

El Niño, a temporary, cyclical climate change initiating in portions of the Pacific Ocean near the equator, is devastating to Peruvians and impacts the rest of the world, Andrus says.

"El Niño is the largest source of inter-annual climate variability in the world," Andrus says. "Peru is the epicenter of this action. And, upwelling is an absolute central component of it. If upwelling changes, it means El Niño changes. If El Niño changes, global climate changes."

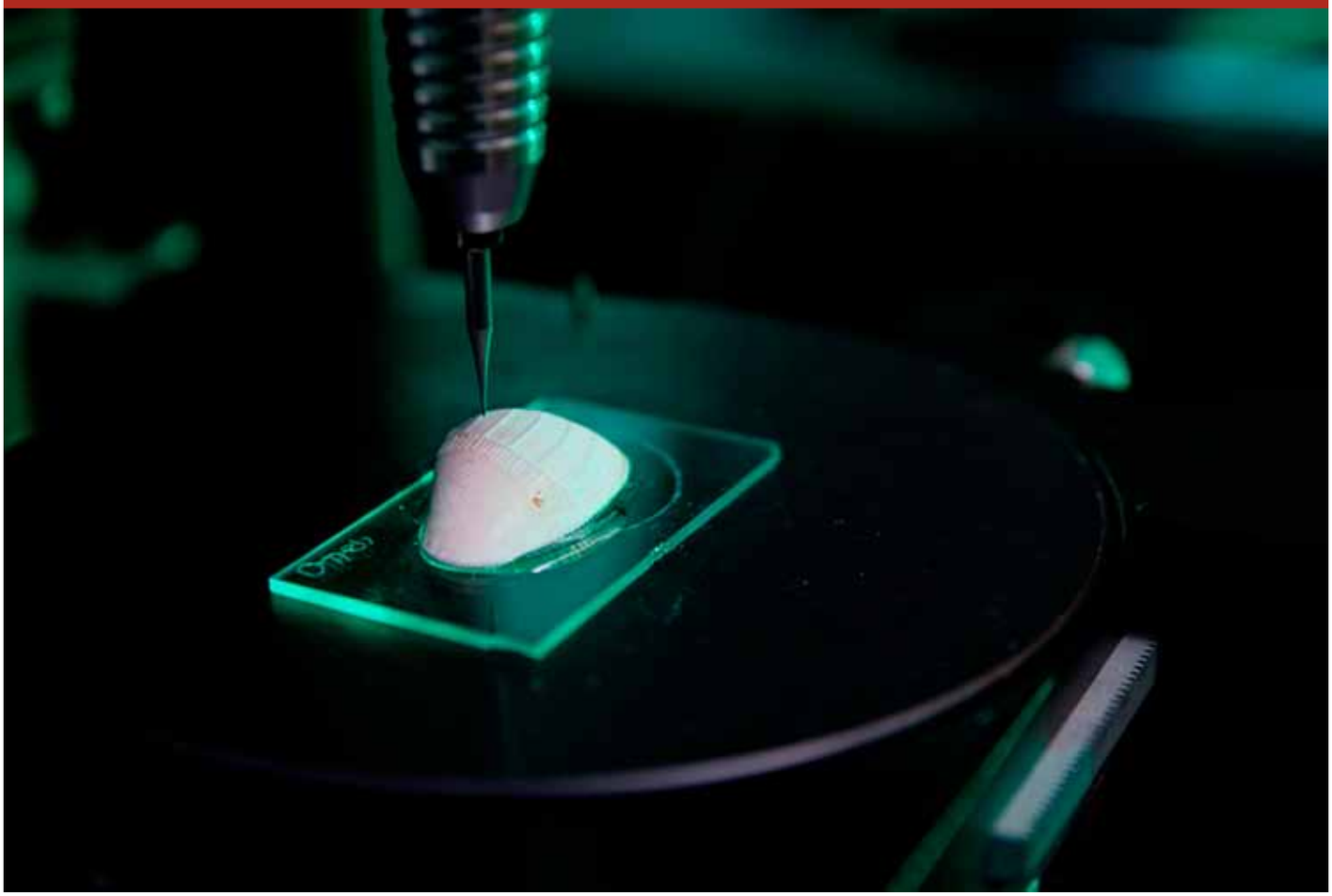
Warming of the ocean by a few degrees, a movement in storm tracks and shifts in the air pressure along an area near the equator are all associated with El Niño.

Typically, the water off Peru's coast is frigid. But, during periods of El Niño, which today occurs about every two to seven years, the water turns tropically warm.

"The deserts get rains," Andrus says. "The currents that are usually strong off of Peru – some of them get weak, while others strengthen. Exotic fish appear that don't typically live in Peru, and the fish that everyone depends upon, like anchovies, all go away, or they die. The sea animals or the sea birds either all go away or they die."

The desert rains devastate the irrigation system, Andrus says, and destroy much of the agriculture. The cities are often inundated with flooding.

While Peruvians bare both the brunt of El Niño's effects and the



*A shell excavated from an archaeological site in Peru is analyzed using a micromill in Andrus' lab. The shell dates from the 1500s.*

most immediate ones, no part of the globe is unaffected, says the UA College of Arts and Sciences researcher.

"The Amazon basin on the other side of the mountain gets drier than it should be. The ocean off northern Australia, which is typically very warm, gets a little cooler. Part of Australia gets severe droughts. Part of Asia may have no monsoons. It changes the tracks of hurricanes in the north Pacific. Conversely, El Niño weakens the Atlantic hurricane season. It changes the location of rainy areas and dry areas in North America. It sets up this global chain reaction."

The El Niño cycle, which we're presently in, is partially responsible for the atypical winter weather the U.S. just experienced, Andrus says.

"So, many people, including myself, have been interested to see how El Niño has changed over time.

While now it happens every two to seven years, more than five thousand years ago it happened much less frequently, and seven thousand years ago, much less frequently than that, and so on, at least back to the last ice age.

"I want to figure out how upwelling has changed because that will tell me, on one hand, how the Pacific Ocean circulated back then and, two, how these civilizations may have been able to make a living."

## Peruvian tombs and Weather Reports

And, as powerful as the Internet seems, there's no archived footage stored online of The Weather Channel's local Peruvian report from 50 centuries ago.

"It's challenging to measure the movement of water 5,000 years ago."

And, that's where the mollusk shells come in.

"If you can find a shell that you already know how old it is, you can measure the radiocarbon, and it will tell about past upwelling there."
And dating those shells? That's where the ancient funerals – and the mummified remains within Peruvian tombs – come in.

Archaeological sites, including tombs thousands of years old, are numerous along the coast of Peru. While the Inca may be the only famous historical culture from this part of the world, there were, Andrus says, dozens of other cultures that pre-date the Incas, including cultures that were powerful empires with gold,

*Dr. Fred Andrus (sitting), Joe Lambert, environmental isotopes specialist, (left) and Miguel Etayo-Cadavid, graduate student (right), work in a UA laboratory.*

standing armies and huge cities, perhaps containing hundreds of thousands of people.

And for many of these cultures, including the Moche, whose founders pre-date the first Incas by more than 1,000 years, the dry climate assists in the preservation of their artifacts … and even their bodies.

"You have these really, really well-preserved burials" Andrus says. "Often times, depending on the culture, the mummies are sitting upright in a tomb, and they will have arrayed around them offerings."

These offering sometimes include food, such as the sea creatures and their shells, and/or jewelry, weapons and tools.

In one set of burials, which draws the specific attention of one of Andrus' graduate students, Christie Jones, offerings of corn and cotton were placed, along with mussel shells, as offerings. "Archaeologists tell us that all these were presented at the same time." Andrus and colleagues radiocarbon date the cotton, corn or other offerings to obtain an accurate estimate of the mummies' ages. "Then, we compare that to what the archaeologists think based on the stratigraphy (the study of sediment layers in the tombs) and artifacts. When we are confident we know the age when someone was buried, then we measure the radiocarbon in the shell, and it tells us what the ocean upwelling was like then. It's a very direct measure.

"These are the exact same types of shellfish that the people ate – living in water that's at the very epicenter of El Niño where the upwelling happened. It's as direct a measure as probably is possible as to what upwelling was like back then."

## Growth Bands Like Trees

Ok, so that explains how scientists know how old the shells are, but how does knowing their age help in determining the conditions of the waters they once lived in? To understand that, you have to explore the basics of radiocarbon dating. Radiocarbon forms in the atmosphere and rapidly mixes throughout it. It takes, on average, about 400 years for this radiocarbon to mix into the ocean. After diffusion at the ocean's surface, it may travel downward with sinking currents.

In the North Atlantic, the ocean's cold, salty waters sinks near to the ocean's floor, taking the radiocarbon with it, Andrus explains. "In the ocean, water that sinks must come back up to the sur-

face."

This rising to the surface, or upwelling, occurs in zones, including one near Peru.

The longer the water has stayed beneath the ocean's surface, the more the radiocarbon within it decays. "Basically, you can date the carbon dissolved in water and learn how long that current has been down deep," Andrus said.

"Seashells have carbon in their shells, lots of it, and they get it from the ocean," Andrus explains. "As a seashell grows, it traps radiocarbon from the water around it. The amount of radiocarbon in the water in a place like Peru is, in large part, a function of upwelling. If you have a lot of old, cold water rising to the surface (because of upwelling) you have what looks like a really, really old carbon date in the shell. If you don't have much upwelling, it appears as if the shell is not as old."

Shells contain growth bands – rings similar to those found in trees. These rings provide hints as to what was happening during a certain portion of the shell's life like a calendar.

## Economy of Early Civilization

*A hieroglyphic from an ancient Peruvain site depicts the importance of fishing to early economies.*

"We would take multiple samples in a single shell, from birth to death, and it would tell us, at this particular moment in a shell's life, it has x amount of radiocarbon, and, in this part, it has y amount of radiocarbon, and it would vary through the life of the shell – up or down along with upwelling. This is like a little key.

"We know how old the mummies are due to archaeological contexts and other types of dating techniques. We have a shell, and we know how old it is. We measure the radiocarbon in the shell and the difference between its real age and its radiocarbon age is, at least in part, a function of upwelling.

"We can go to these archaeological sites, collect shells and measure fairly directly how much upwelling was happening at the time the people lived there, and then infer how abundant fishes were, what the coastal ecosystem was like and, since these people were depending upon fishing, maybe how hard it was for them economically."

*UA graduate student Miguel Etayo-Cadavid uses a syringe to inject acid into a vial containing samples for isotopic analysis.*

Miguel Etayo, a UA doctoral student, is also immersed in the research and is studying remains left in Moche tombs near the pyramid sites of Huaca de La Luna.

Andrus is awaiting final data from the research, but is intrigued by early indications.

"We are detecting changes in upwelling through time. Sometimes they are very sudden changes and happen very quickly.

"I'm trying to understand the foundation for the climate and economy of early civilizations of South America."

And the mummified remains of some of the members of those civilizations, and the shells from the animals they consumed, are both assisting with that understanding.

# Storing Captured Carbon Pumping $CO_2$ Deep Underground A Potential Alternative For Greenhouse Gas

Written by Chris Bryant /Photos by Zackary Riggins

The odds of predicting when the United States would pass major climate and energy legislation appear, like the weather itself, to be somewhat cyclical.

At various times since the Kyoto Treaty was first adopted almost 14 years ago, it has appeared any such legislation was either imminent, years away, or most any point in between.

In July 2010, some speculated that the Senate's then inability to bring legislation on a greenhouse gas emission trading system to a vote was a death knell. Less than one month later, however, the White House's top energy adviser suggested that a cap-and-trade bill might be passed following November's mid-term elections.

Despite the ever-swinging pendulum representing momentum, or lack thereof, behind such legislation, Dr. Peter Clark, a University of Alabama petroleum/chemical engineer, says the question, to him, has always been a matter of when not if.

"As much as people would like to pretend it is not going to happen, there is going to be a tremendous amount of pressure from the rest of the world to do this," Clark says. "Clearly, it's better to get ready to do it at this time than to wait and to later be in a panic."

A trio of University of Alabama researchers, in collaboration with various governmental and commercial entities, is exploring one avenue, carbon dioxide storage, which could prove helpful to industry in getting ready for any future reduction requirements in greenhouse gas emissions.

Three separate research projects, funded with nearly $13 million, involve UA scientists seeking to better gauge the feasibility of pumping carbon dioxide into the ground for long-term storage as an alternative to releasing the greenhouse gas into the atmosphere.

## PAY NOW OR PAY LATER

"Under cap and trade, utility companies are either going to have to pay for their $CO_2$ emissions or they are going to have to sequester them in some fashion," Clark says. "They can trade carbon credits if they want, but to generate their carbon credits they have to save either at the generation of $CO_2$ or they have to inject, or otherwise dispose, the $CO_2$ some place. For big coal-fired electricity plants, the cost of buying enough credits to continue to put $CO_2$ into the atmosphere would be high, so they see sequestration as one way to potentially solve the problem."

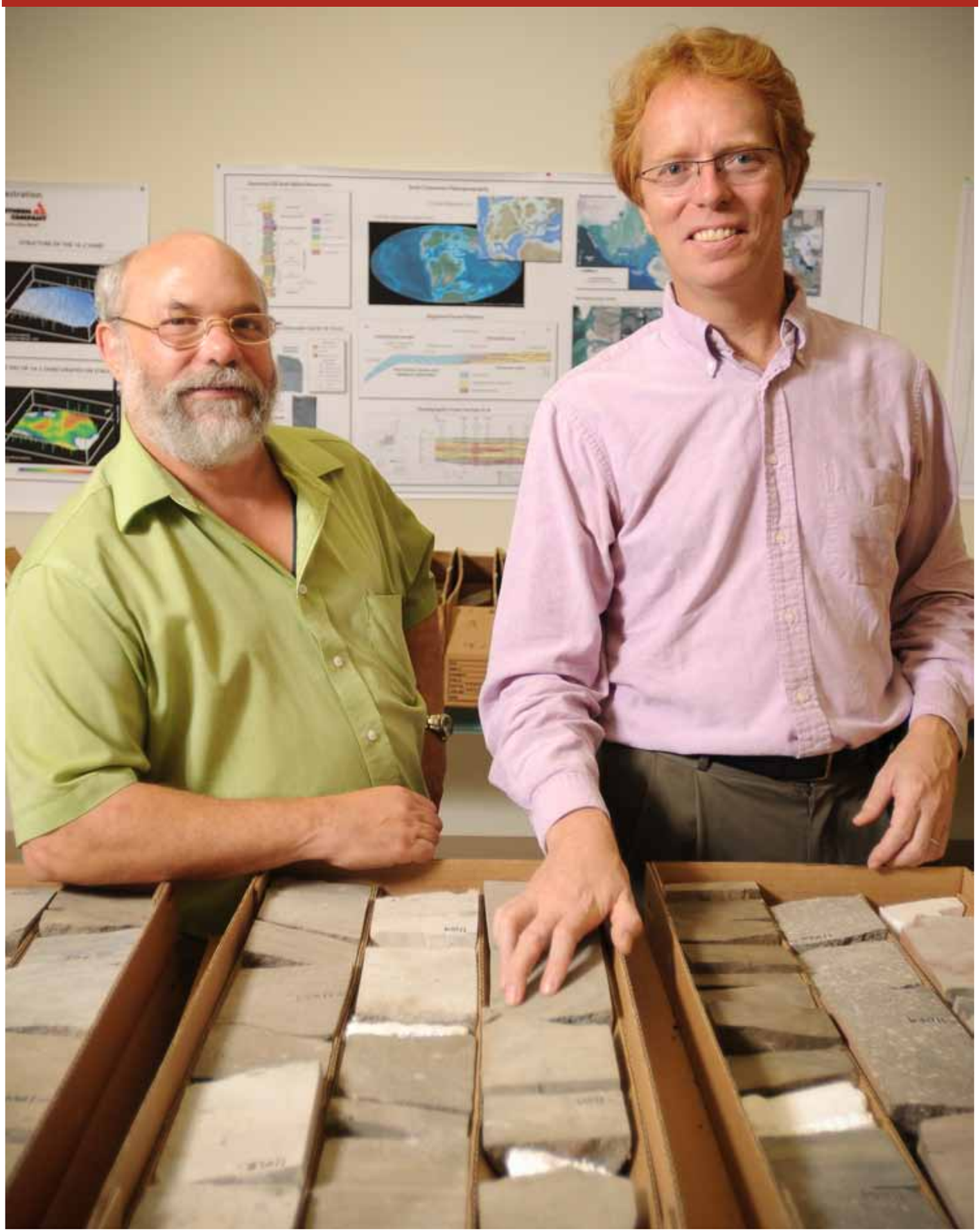
In one project, Clark leads a team of scientists, including UA colleagues Drs. Eric Carlson and Andrew Goodliffe, in studying whether a saline reservoir, more than one-half mile below the surface and stretching across a large swath of the state, is a good option for storing carbon dioxide.It has potential. And, it is not alone.

"Alabama is probably one of the best places to do carbon sequestration because we've got great reservoirs," says Goodliffe, a UA geophysicist. "What we have in the Black Warrior River basin are big power stations and some beautiful geology beneath them. And that geology is potentially an ideal reservoir for carbon sequestration storage."

While the term "saline reservoir" might suggests to the lay person a cavernous opening underneath the surface, with a wide saltwater stream flowing through it, that's not the case, the researchers say.

Instead, such reservoirs typically consist of a host of tiny spaces within underground rocks.

"In a good saline reservoir, you might have 30 percent porosity," Goodliffe says, "which means that 30 percent of that rock is holes that you can potentially put water, oil, gas, whatever, into."



*Drs. Jack Pashin, left and Andy Goodliffe reviewing rock samples.*

## LOCATION, LOCATION, LOCATION

However, thinking this means there's not much available space in which to potentially store carbon dioxide is also incorrect. "The Tuscaloosa trend that starts just south of the mid-part of Alabama and runs clear off shore is just mammoth," says Clark. "Just the onshore part is 69 gigatons of carbon dioxide storage."

Alabama Power and Southern Co. are corporate sponsors of the Department of Energy-funded project, and the research site is near Alabama Power's William Crawford Gorgas Plant in Walker County. In fact, the real estate axiom, "location, location, location," identifying the three most important attributes of property, come to mind for this project, as well. By investigating the geology near existing power plants, costs associated with later transporting carbon dioxide from the plants are greatly reduced.

Fewer than five miles from Gorgas is Alabama Power's Miller plant. And it's Miller's emissions, not Gorgas', that are the potential target for this carbon storage project. The geology underneath Miller is not as well suited for carbon storage, Clark says, but its close proximity to Gorgas lessens any future costs related to transporting carbon dioxide.

Carbon dioxide, a major greenhouse gas, contributes, the majority of scientists say, to climate change. Its atmospheric concentration levels have increased, at least in part, because of the consumption of fossil fuels. In theory, this new approach to carbon storage would work by removing carbon dioxide from flue gas emissions, compressing it into a liquid and pumping it into the underground saline reservoirs via wells.

Capturing the carbon dioxide is a significant hurdle – one being tackled by other researchers – while this UA-led team is focusing on assessing the underground storage capacity and its capability to keep the $CO_2$ safely in place, long-term.

Over the next three years, the team will create and analyze – using seismic reflection technology – a detailed image of the geology below the surface, build geological and reservoir computer models to predict potential outcomes of injecting and storing the carbon, and drill and test an 8,000-foot well by which the carbon dioxide could be injected. However, at this stage of the project, it will be fresh water, not carbon dioxide, that will be injected.

"We will inject a small volume of fluid into the hole – and there will be down-hole pressure sensors – and we will do so at a number of different pressure and flow rates," Clark says. By analyzing the data from the tests, researchers get a better idea of the site's potential permeability and injectivity.

## UNDERGROUND ACOUSTICS

Using core drills, the researchers will remove large cylindrical sections of rock, three to four inches in diameter and as much as 30-feet-long. Repeating these steps, layer after layer, provides the researchers enormous sections of rock for laboratory analysis.

But, alone, these steps don't necessarily give an accurate indication of the characteristics of underground areas surrounding the drill sites. Researchers also use a large vehicle, known as vibroseis truck, to send acoustic signals, via vibrations, deep underground. Those signals reflect off the various rock layers across a five-mile line and to a depth of more than 10,000 feet. The signals are received back at the surface by sensors known as geophones.

"By analyzing all those vibrations, we actually build up a two dimensional image of the subsurface," says Goodliffe. "The combination of those two, the seismic data and the well, allows us to take that well data and say, 'we know the geology at the one location, and, using the seismic data, we can extrapolate that out. I can start to build up a very detailed image of what the rocks are within the basin."

Another key step involves placing sensors in the bore hole and measuring how long it takes acoustic pulses sent down the hole to reflect back to the geophone sensors at the surface. Goodliffe explains.

"When we drill our well, that's in depth. We've got to come up with a way to correlate time to depth. That acoustic signal travels down the bore hole, and we know how long it takes to reach these acoustic sensors in the subsurface, and we know the depth of those sensors. That gives us a direct tie between time and depth and allows us to take that time section and correlate it directly to the bore hole."

Carlson, a UA petroleum engineer and computer modeling expert, will take the seismic data, along with reams of additional data provided by other research partners, and develop multiple mathematic models. "Once we have the mathematical models, we will take and translate those in a way that our computers will be able to simulate, over many, many years, what happens as we inject $CO_2$ into the formation," Carlson says.

"Does it react with something and precipitate out? Does it continue to move and move and move? Do we inject it, and … it goes up fractures and faults?" Or, in a more promising scenario, do the simulations indicate that 99 percent of the carbon will stay in place for more than 1,000 years – a desired outcome.

## SIMULATING POSSIBILITIES

To visualize the computer simulation effort, Carlson suggests thinking of a room – representative of the reservoir – divided into tiny compartments, or cells, all stacked atop and beside one another.

"We assume, based on certain mathematical descriptions, that we will allow things to flow from one cell to another. Eventually, something we inject down here," Carlson says, while pointing to the lower corner of his office, "will eventually possibly make it over here to some other corner.

*The geology of surrounding Alabama Power's Gorgas Steam Plant may be well suited for long-term underground storage of carbon dioxide. (Alabama Power)*

"For each of these cells, there will be physical properties that we will use to describe that," Carlson says. "Things like $CO_2$ concentrations, pressures, temperatures, stresses, amount of water – there are many things we will track inside each of these cells.

"We will not be doing a single simulation," Carlson says. "We will be doing what we call realizations. We will generate – using some random, intelligently constrained, but otherwise random – assignment of certain characteristics. We might run tens or hundreds or thousands of these simulations just to get a picture."

Carlson says the first step, for him, is to develop the computer infrastructure and software capable of handling such large-scale simulation. Software and a single PC used in the project must have the capability, initially, of simulating 50 million cells. "It's very plausible that at the end of three years, I will be up to 500 million cells on maybe five machines."

## WILL IT STAY PUT?

The modeling's end result will attempt, Carlson says, to answer questions such as how much $CO_2$ can be injected into the reservoir, what happens to it once it goes in, how quickly it can be injected and where it can be injected. "And, probably the most important question, from the standpoint of carbon storage, does it stay in the ground?"

In a second Department of Energy-funded project, Clark and Carlson are joining with researchers from the Geological Survey of Alabama and elsewhere to study not only storing carbon dioxide at another site, but, simultaneously, to also use the $CO_2$ injection as a means of increasing the amount of natural gas that can be recovered from various coalbed methane sites in Alabama.

"This will help pay for the cost of capturing and injecting the carbon dioxide," Clark says. At a Tuscaloosa County test site, chosen for its characteristics which are representative of others in the Black Warrior River basin, the researchers began injecting $CO_2$ in June. Over a 60-day period, the researchers injected 240 tons of $CO_2$, while monitoring factors such as reservoir pressure, gas composition, water quality and the $CO_2$ plume, itself. When $CO_2$ is injected into a coal seam, it displaces the methane gas. The injected $CO_2$ absorbs onto the coal where it is stored.

Coal sites within the 23,000-square-mile river basin have the potential to store between 1.1 and 2.3 gigatons of $CO_2$, the researchers say. This is roughly the same amount of $CO_2$ produced by Alabama's coal-fired power plants in two decades. Research-

ers estimate that another 1.5 trillion cubic feet of natural gas that might otherwise go unclaimed could be generated through the use of $CO_2$ injections. In addition to UA, partners include Southern Company, El Paso Exploration and Production and the Geological Survey of Alabama.

In a third project at Citronelle Oil Field in Alabama's Mobile County, researchers are, in similar fashion, hoping to force additional oil from the field by injecting $CO_2$ into the site and pushing the oil forward. Such enhanced oil recovery efforts have "almost completely revived" the oil industry in West Texas, Clark says.

## STUDENTS TO BENEFIT

In addition to the potential environmental and industrial benefits that would result from the carbon storage projects, Goodliffe says the benefits to those University of Alabama students involved in the research will be significant.

"In five to 10 years, carbon sequestration is going to be its own industry," Goodliffe says. "I'm really excited for our students because they have the chance to get in on the ground floor. There are very few people who are actually going to be trained directly in this. They will be ready to hit the ground running, and my goal is that they will be running these companies in 10 years time."

And don't think Clark hasn't heard the arguments that the impact of $CO_2$ emissions into the atmosphere is overblown and unrelated to higher temperatures.

"Clearly, coal and oil are generated from materials, mostly plants, that were alive at one time," Clark says. "So, there's the argument that $CO_2$ was taken out of the atmosphere when the plants were buried and all you are doing is putting back the $CO_2$ that was there naturally. But, the fact remains that when you generate huge amounts of $CO_2$ through burning, you upset the natural processes of generation and use of $CO_2$. You've put in a source of $CO_2$ that isn't part of the natural system."

"Whether you believe in global warming or not, the things we are doing it to combat it – developing higher efficiency techniques – perhaps capturing $CO_2$ – are things we should be doing anyway. We should be looking for more efficient cars and more efficient ways to run our household. We can't go and make plastic forever without recycling some of it.

"You can make a good case for global warming, and you could make a good case that this is sort of a natural heating that is occurring because of the cycles that we go through. We've gone through high-temperature cycles and low temperature cycles. But, you can't argue that the $CO_2$ concentration is going up in the atmosphere. There's no doubt about that."

In The University of Alabama-led project at the Alabama Power site, researchers from UA's colleges of Engineering and Arts and Sciences (Geological Sciences) are collaborating with the Alabama Geological Survey, Rice University and Schlumberger. In the Black Warrior $CO_2$ Storage Project, UA researchers are partnering with Southern Company, El Paso Exploration and Production, the Geological Survey of Alabama and the Electric Power Research Institute, known as EPRI. In the Citronelle Oil Field Project, led by the University of Alabama at Birmingham, UA researchers collaborate with Denbury Resources Inc., Southern Company and Alabama A&M.

# *NASA Grant Allows UA Student to Peer into Active Volcano*

On weekends, University of Alabama graduate student Jonathan Stone is the lead guitarist for the rock band Lunar Rain, but Monday through Friday he can be found in a lab conducting scientific research that has the potential to one day save lives. Stone's work at UA is focused on predicting the timing and scale of a volcanic eruption.

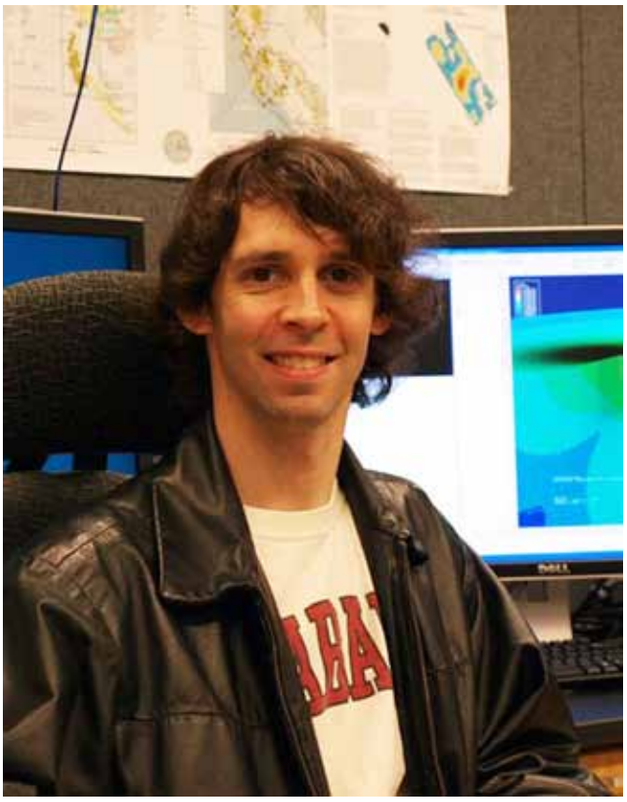
He is studying the Okmok Volcano in Alaska, working from a UA lab on computer-based research.

Stone was recently awarded a highly competitive NASA Earth and Space Science Fellowship that includes a grant of $90,000 ($30,000 annually, renewable for three years) to support his research. Through Stone's work with NASA, he is able to access satellite images of outer volcanic activity and use mathematical analysis to predict activity on the inside of a live volcano.

"Jonathan is giving us a window to the inaccessible guts of a volcano," said Dr. Timothy Masterlark, assistant professor of geological sciences at UA and Stone's major professor.

Stone's research could one day make evacuation plans more accurate for people living in the shadow of an active volcano. Scientists could determine when an eruption would take place and estimate the magnitude of danger it would bring to neighboring areas, likely saving lives.

A scientist and a musician, Stone admits to spending any free time traveling and playing in his band. He has visited all 50 states and six continents. His band, Lunar Rain, is based out of north Alabama and was started in the fall of 2009. The three-man rock band is currently recording its first album and has had its song "Deny" play in Huntsville and Atlanta.



*UA graduate student Jonathan Stone*

"He has such a diverse set of interests," Masterlark said of his student, "I consider him a true Renaissance Man." Stone is currently pursuing a master's degree in the UA department of geological sciences, under Masterlark's direction.

The UA student was one of 55 chosen from an applicant pool of 278 master's and doctorate students across the nation for the NASA award. Stone and Masterlark said they were skeptical when Stone, a graduate student, applied for such a prestigious award.

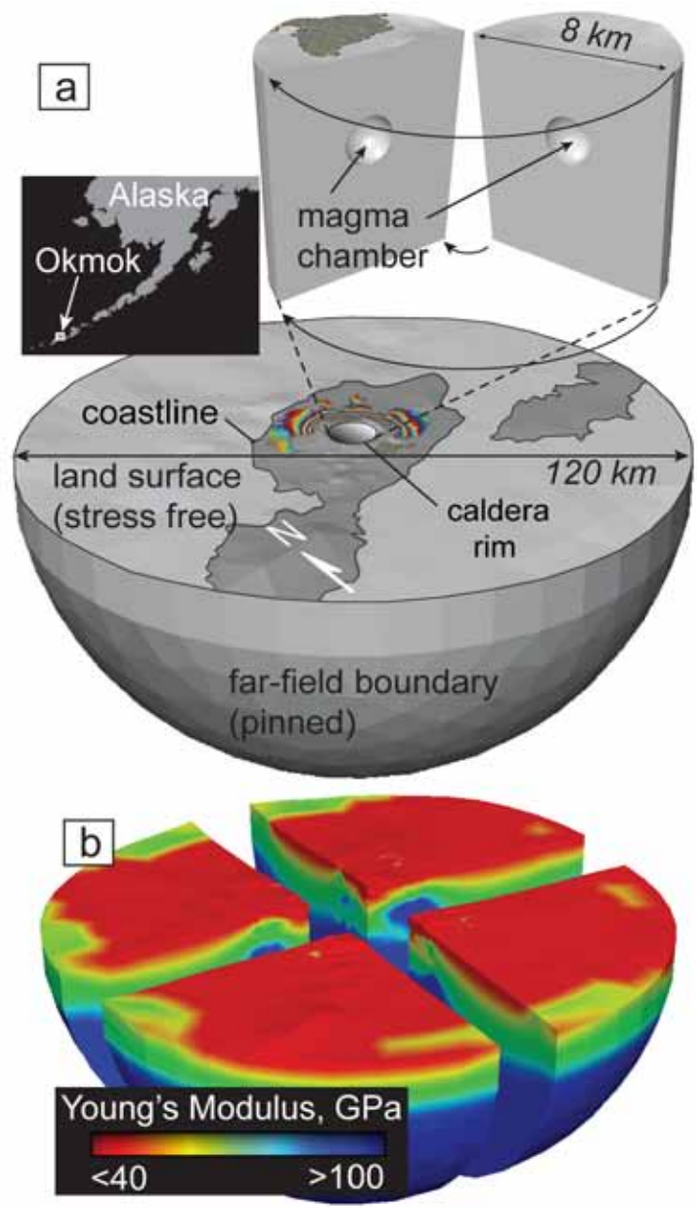
"The competition was steep, I was shocked to have received the award," Stone said.

"It is going to be hard to find another master's student to reach this level," Masterlark said, "Jonathan is truly remarkable."

Stone completed his undergraduate study at Middle Tennessee University and says he chose UA for his graduate study largely because of the faculty.

This award allows the UA student to continue his research in a way that could have a long-term impact, his professor suggests. "Jonathan will revolutionize the way we think about volcanoes," Masterlark said, "it hasn't been proven yet, but I'm optimistic."

The department of geological sciences is part of UA's College of Arts and Sciences, the University's largest division and the largest liberal arts college in the state. Students from the College have won numerous national awards including Rhodes Scholarships, Goldwater Scholarships and memberships in the USA Today Academic All American Team.




Figures a and b above;

(a) Finite element model (FEM) for the deformational system of Okmok Volcano, Alaska. Color 'fringes' are satellite radar data, superposed for reference.

(b) The FEM configuration includes the internal structure of the volcano, which was derived with seismic tomography. Preliminary results were presented at the AGU Fall Meeting 2010, in San Francisco, CA.

# Geological Sciences Advisory Board

## ~GSAB~

The Geological Sciences Advisory Board (GSAB) was founded in 2002 and includes alumni, corporate, governmental and community members. The GSAB supports students, faculty and staff in the Department of Geological Sciences at The University of Alabama. The Board also serves as a liaison with the business community and government in order to promote the interests of the Department within The University of Alabama, the state and nation. A primary goal is to help recruit and retain talented, competent, motivated students and faculty. This is accomplished by providing scholarships, employment opportunities for students and support to retain talented faculty. To date, the GSAB has raised and awarded $80,000 in scholarships that have supported 25 geology students. The GSAB has endowed two scholarship funds valued at $1.045 million in current and pledged gifts.

The GSAB holds two meetings each year. In the fall, the GSAB meet at the UA campus on the Monday following homecoming weekend. In the spring, the GSAB often meet at a location where Department of Geological Sciences research is taking place or a city where there is a concentration of Alabama alumni. These meetings are well attended by members, faculty and students. Time is always provided for social events and field trips.

Annual membership dues for the GSAB is $500. These funds go directly to support and help students. Corporate matching or other employer sponsorship is encouraged and welcomed. In addition, the GSAB members are raising funds for the Geological Sciences Advisory Board doug Jones Endowed Scholarship, which will begin providing student scholarships when it reaches $250,000.

If you have questions or would like to discuss the GSAB and the Department of Geological Sciences, please write Dr. Ibrahim Çemen (icemen@as.ua .edu), or call (205) 348-8019.

# Undergraduate Focus

## Fred Andrus, Undergraduate Program Director

The department has been enjoying healthy growth over the past few years, even slightly outpacing the considerable expansion of the university as a whole. Presently we maintain between 70 and 80 majors. The quality of our students is high as well. For example, we have four upperclassmen with 4.0 averages. This makes it a challenge to sort out who wins our departmental awards, but that is a great problem to have.

Additionally our majors increasingly participate in research. Many currently enroll in our research-for-credit courses, where they get hands-on experience in our laboratories and in the field. This sometimes results in presentations in university, regional, and national conferences. We hope this better prepares our students to meet research expectations in the professional and graduate world. Some of our majors take this even farther by participating in off campus programs, many of which have highly competitive application pools. Last year students participated in NASA-sponsored workshops and conferences, National Science Foundation Research Experience for Undergraduate programs (NSF-REU), and summer leadership schools. Several majors have applied to other NSF-REU's, NASA programs, geophysics workshops, and inter-university student exchanges this upcoming year as well. We are proud of their achievements and hope they are selected for these prestigious programs.

Internships are another great opportunity for our students to earn course credit and gain valuable experience. Each semester several students intern at the Geological Survey of Alabama. The students work on projects including studying hazards, mapping, environmental assessment and remediation, hydrology, and energy issues. We are grateful to the Survey for their generous mentoring and hope to see this program continue. Other organizations also contact us seeking interns in the energy, building materials, environmental, and consulting fields, and we have placed several students in these positions. We would like to see these opportunities expand and will gladly facilitate matching the students should other organizations contact us.

In summary the undergraduate program is strong and expanding. As the department adds new faculty we are planning to increase the number of majors and course options while maintaining our department's culture in which we value giving each student personal attention and provide close mentoring. We like to maintain this close-knit culture even after graduation, so please contact us and keep us informed of your activities.

# Student Scholarships & Awards

Each year we have outstanding students whom we acknowledge during Honor's Week, which takes place April 4 - 8, 2011. The annual Honor's Week continues to acknowledge those whose hard work and creativity reflect well on our Department and The University of Alabama's commitment to quality research, instruction, and service. The following students have been recognized this year for their accomplishments.

**Walter B. Jones Scholarship**
*Sarah Bailey*

**Jen-Ho Fang Scholarship**
*Mitchell McMillian*

**Outstanding Senior Award**
*Daniel Fields*

**Outstanding Senior Award**
*Jacob Spry*

**Outstanding Research by a Ph.D. Student Award**
*William J. Lambert*

**Outstanding Research by an M.S. Student Award**
*Jonathan Stone*

**Outstanding Teaching by a Ph.D. Student Award**
*Kelley W. Rich*

**Outstanding Teaching by an M.S. Student Award**
*Matthew McKay*

**Outstanding Service by a Graduate Student Award**
*Erika Rentschler*

Walter B. Jones and Jen Ho Scholarships provide $3,000.00 for outstanding undergraduate students. Outstanding seniors awards comes with $500.00 cash prize. The graduate student awardees receive $500.00. All these monetary awards are made possible from donations by our alumni.

# Graduate Student Notes

## Andrew Goodliffe, Graduate Program Director

The Graduate Program in the Department of Geological Sciences is flourishing. The department currently has a graduate student population of forty-nine. Thirty-one of these students are pursing M.S. degrees and eighteen are pursuing Ph.D. degrees. Many faculty have commented that the current graduate students are among the best that we have had. This perception is backed up by statistics, with a marked increase in the GPA and GRE of incoming students in recent years. Our graduate students are well funded. An increase in teaching assistantship positions means that twenty-one of our gradate students are currently supported through teaching undergraduate labs. Fourteen of our graduate students are supported on research assistantships. Funding for these positions comes from the National Science Foundation, the Department of Energy, and industry. Four graduate students are supported through fellowships. All of these fellowships are highly competitive and only awarded to the best students. Two of these fellowships were awarded by the UA Graduate Council, one by NASA, and one by the McNair Program. The remaining ten students are typically self funded, but often have alternative employment on campus.

We have currently received thirty-seven applications for fall 2011 admission into the Department of Geological Sciences Graduate Program. These include 26 applications to the M.S. programs and 11 applications to the Ph.D. program. These applications indicate that our graduate program will continue to grow in both quality and size.

# Faculty and Staff Activites

## PAUL AHARON
## Loper Chair Professor

**IN THE YEAR OF THE TIGER**

According to the Chinese zodiac years, 2010 was the "Year of the Tiger" that meant to be a successful and profitable year. For me, and the graduate students in my group, 2010 was indeed a banner of research accomplishments. I am still in the process of figuring out whether these accomplishments were foretold by the zodiac, resulted from hard work, or both.

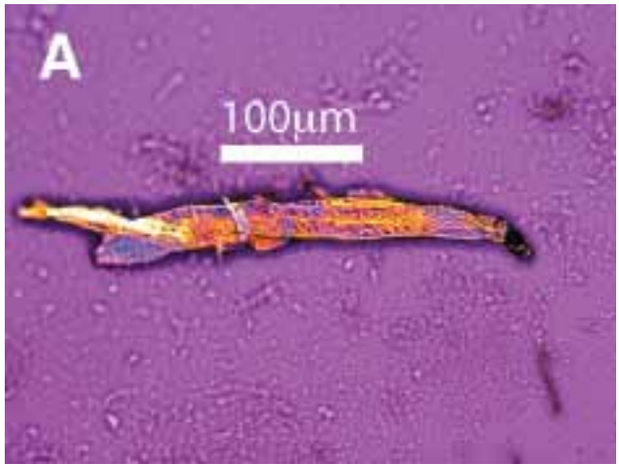
First, three members of the **SPELEO-TEAM** group have graduated and received the diplomas. Val Murgulet and Joe Lambert were handed their PhD degrees during May and December graduations, respectively. Also, in December Rajesh Dhungana successfully defended his thesis and graduated with an MS degree. Subsequently, Rajesh was accepted in our doctoral program and continues his study of speleothems from DeSoto Caverns over the time interval 0-6000 yrs. In order to maintain the balance, two new graduate students, David Aldridge and Hunter Phillips, have joined the **SPELEO-TEAM** group. David is uncovering evidence from stalagmites at DeSoto Caverns that links past severe droughts in the South with the demise of the native American-Indians chiefdoms in the southern USA; Hunter is figuring out how to extract paleoclimate records from diagenetically altered stalagmites at DeSoto Caverns. Joe Lambert and myself have published two seminal papers on oxygen, hydrogen, and carbon isotopes in the drip-stalagmite system of DeSoto Caverns that serve as the "yardstick" for the interpretation of climate events over the past 32,000 yrs. In October, I led a field trip of GSAB members and graduate students to DeSoto Caverns that serve both as a natural research laboratory as well as a convenient teaching venue. Our DeSoto Caverns studies were supported by two grants from GCAGS and the Alabama Climatology Office. At the completion of the projects, and after submitting the reports, I got the following message from the GCAGS granting officer:

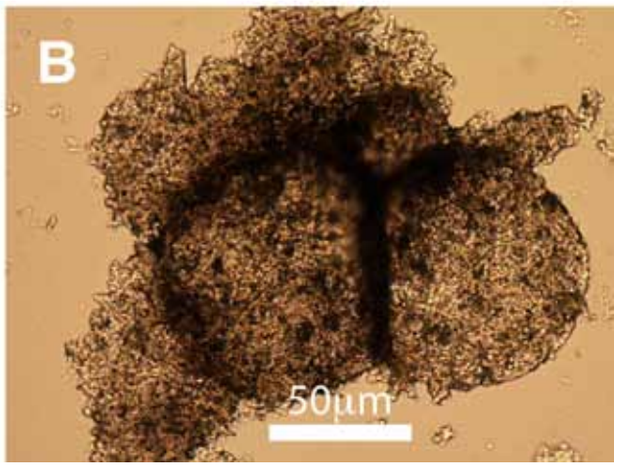
*"Thank you for the update and final report--this is very interesting work! I will forward this information to the Board of Directors advising them of your progress and publications indicating that these research dollars were very well invested in you and your work. Well done."*

In order to maintain the cash flow of research funds I submitted a grant proposal to NSF to obtain funding for a study of caves and speleothems on the Polynesian Island of Niue and reconstruct El-Niño-Southern Oscillation for the past 10,000 yrs, the primary modern global climate engine. In August, I was delighted to find that the proposal was successful and has been funded for three years at a level of near $500,000. We are planning a long and tedious field trip to the South Pacific in July-August 2011 but nobody is complaining for traveling and working in such an exotic place. The stable isotope laboratory (**ASIL**) for which I serve as the faculty director has adopted three faculty shareholders whose graduate students are busy using the facilities. In order to streamline the bustling laboratory schedule I served as a Co-PI on an NSF instrumentation proposal (with Fred Andrus and Alberto Perez-Huerta) whose aim was to purchase a new machine. The proposal was successful and funded at a level exceeding $200,000. We are now in the process of purchasing a second, fully-automated mass spectrometer, that after installation will ease the long cue of users.

Finally, curiosity, accompanied by discoveries, is the primary driving force that keeps our motivation high. Below I am sharing a couple of brand-new discoveries made by David Aldridge while studying a cored stalagmite from DeSoto Caverns.

Plate 1. (next page) Photomicrographs of palynomorphs ensconced in an aragonitic stalagmite from DeSoto Caverns. Ages were obtained using the U/Th radiometric dates of the hosted stalagmite. A. Burned river cane fragment ~2000 yrs old; B. Burned pollen grain of oak ~1500 yrs old. The evidence of ashed palynomorphs that arrived at the stalagmite from the surface soil through dripwater is assisting us in testing the hypothesis that native American-Indians were engaged in slash and burn activities during the emergence of native agriculture in the South (images courtesy of David Aldridge).




## FRED ANDRUS
### Associate Professor

Once again this has been a busy and exciting year for me and my students. I was pleased to have been promoted and awarded tenure. Perhaps the biggest news however was the graduation of Miguel Etayo (Ph.D.) and Christie Jones (MS). Miguel is now with BP in Houston, though he is still working with me and publishing different aspects of his dissertation research into radiocarbon upwelling proxies for coastal Pacific South America. Christie is now considering either pursuing her Ph.D. or seeking work in a stable isotope lab. She is also working on publishing her thesis on the biomineralogy of some South Pacific mollusks. Jestina Hansen hopes to finish her MS this semester as well, working on methods of analyzing nitrogen isotopes in mollusk shell. She has a journal manuscript ready to submit now that I think will be heavily cited by other researchers. I am proud of each if these students.

Robin Cobb (MS student) and I had a great experience at the Johannes Gutenberg University in Mainz Germany this past summer. We both gave papers at the 2nd Annual Sclerochronology Conference, where I was honored to have been asked to give a keynote. Robin also had quite an adventure on a NOAA-funded research cruise on the *RV Pisces* to the Blake Plateau off of the coast of Georgia. She sampled deep water corals using a remotely operated submersible. Her work was profiled in several UA publications and newspapers.

Kelley Rich (Ph.D. candidate) continues her work in Belize, and is entering a new phase of her research into finding biogeochemical proxies to investigate drought that may have impacted the Maya. Kelley is also helping me keep my busy micromilling lab up and running. We have two undergraduate student employees working in the lab preparing samples for various projects. Sara Glenn is helping me analyze oyster samples impacted by the Deepwater Horizon oil spill as part of a recently funded project to assist in the cleanup. Heather Black is micromilling clam and oyster samples for isotope analysis from an archaeological mound site on the coast of Mississippi (working with colleague John Blintz in Anthropology). Both are also helping me analyze samples from a project that was recently funded by the National Science Foundation (NSF). These are clam and oyster samples from several archaeological sites on the Gulf Coast we hope will help us better characterize human-environment interaction over time.

The upcoming months should be exciting as well. I, Paul Aharon, and Alberto Perez-Huerta were awarded an NSF grant to purchase a new isotope ratio mass spectrometer. We hope to set it up this summer. This will double the capacity of our lab (we run 24/7 now and have a constant backlog of prepped samples), and open up new analytical methods for us to use. Also, I will attend an AGU-Chapman conference on “Climates, Past Landscapes, and Civilizations” in New Mexico where I will describe my geoarcheological-climate research. Also, Heather Black was recently awarded a McNair fellowship and I will serve as her advisor over the next year conducting research on deep ocean coral fossil taphonomy.

On other fronts, I have kept a full slate of classes, and am co-teaching an interdisciplinary course as part of the new Evolutionary Studies minor. I have also been busy with the ALLELE Evolution speaker series where I hosted Mary Schweitzer from NCSU speaking on dinosaur soft tissue discoveries. I am in my second year as an Arts and Sciences Leadership Board Faculty Fellow and my third year as the department’s Undergraduate Director. One of the best parts of that job is getting to know the students better and I would love to hear from you after graduation, so drop me a line.

## IBRAHIM ÇEMEN
### Professor and Chair

My first year at the UA Department of geological Sciences was mostly spent learning my duties as the new chair. Indeed, there was a lot to learn. Now, I am half way through my second year, and able to find some time to get my research going again after almost a year and a half of hiatus.

I am continuing to work on my Arkoma Foreland Basin project

and extending it to the Black Warrior Foreland Basin of southern Appalachians. My structure group uses surface geological maps, different types of e-logs, and seismic reflection profiles as tools to determine the geometry of the structural features. Our main goal is to provide a better understanding of the structural geometry and evolution of the Pennsylvanian structural features in the Arkoma Basin to help oil and gas industry to locate structural traps. Recently, we started to use the 3D inverted seismic data to define the relationship between and seismic impedance and porosity in the sandstone reservoirs of the Arkoma Basins. This research is getting National and International recognition. The March, 2011 issue of the AAPG Explorer had a feature article in our recent work in the Arkoma Basin. I have one M.S student, Jeff Fuchs, working on a thesis project in the mid-Atokan Red Oak sandstone reservoirs of the Arkoma Basin.

I am also getting involved on several projects in the Gulf of Mexico. Last year when the BP Deepwater Horizon well collapsed and caused a huge environmental disaster, Patty Savocky, Chair of the Department of Biological Sciences, and I organized a group to get involved in a cleanup research. After several group discussions, the University of Alabama received research support from the funds allocated to the State of Alabama from BP. In January, 2011 the Department of Geological Sciences awarded over half million dollars grants support as seed money to initiate research projects to assess the effect of the oil spill and effectively cleanup the environment.

*Cemen in field in western Anatolia, Turkey.*

As the Southeastern Region Lead Organizer of the Petroleum Technology Transfer Council (PTTC), I have recently organized a workshop on "The Role of Carbon Capture and Storage in Rejuvenating and Diversifying the Energy Portfolio of the Southeastern United States." The workshop was a great success largely due the tireless efforts by Jack Pashin of the Alabama Geological Survey, and Peter Clark of the Department of Chemical Engineering at the UA.

I have also been conducting research in extensional tectonics in western Anatolia, Turkey and the Death Valley Region of southwestern USA. We are comparing extensional structures in two regions and understand extensional tectonics processes. I have a M.S. student, Brandon Lutz, working in the Death Valley region. The student is working on determining Cenozoic strike-slip movement along the Southern Death Valley-Furnace Creek fault zone with correlating pre-Cenozoic thrust faults on each side of the fault zone.

In June 2010, I finished editing my long-waited Tectonophysics Special Issue on "Extensional Tectonics in the Basins and Ranges, the Aegean and Western Anatolia." The special issue is published as Tectonophysics, volume 488 and is available both in print and online.

## RONA DONAHOE
### Professor

The past year has been busy, but relatively uneventful, for Rona Donahoe. She taught both GEO 470/570 (General Geochemistry) and GEO 571 (Thermodynamics) in Fall 2010. General Geochemistry had an enrollment of 17 students, which is the second highest enrollment the course has had during her 27 years of teaching. This spring, she is teaching GEO 105 (Sustainable Earth). A new course, GEO 104 (Hazardous Earth) is in development and will be taught for the first time in Fall 2011. Rona is currently advising four Doctoral Degree students and two Masters Degree students, the newest of whom joined the Department in January. She is also supervising two undergraduate students this semester who are helping with her externally-funded research projects.

The first project is now in the second of three years, and is supported by the Department of Energy's NETL program. The goal of the project is to model fluid-rock interactions induced by supercritical $CO_2$ injected into the Donovan Sandstone for carbon sequestration and enhanced oil recovery at Citronelle Oil Field, which is located in northern Mobile County. Amy Weislogel and her group at the University of West Virginia, are characterizing the geochemistry and petrology of the reservoir rock. Rona's group at UA is sampling monthly four producing wells located around the injection well, characterizing the formation fluid chemistry and performing the geochemical modeling.

The second project, which began in January 2011, is investigating the impact of the BP Deepwater Horizon oil spill on the geochemistry and microbial communities of coastal sediments along the Gulf Coast of Alabama. This interdisciplinary project also involves Yuehan Lu, a biogeochemist who joined the Department in August 2010, and a group of microbiologists from UA, Auburn and Jacksonville State University. The group will use experimental microcosm and mesocosm experiments to simulate and study changes in the organic and trace element geochemistry, and in the microbial ecology of salt marsh and estuarine sediments, caused by oil and dispersant contamination. The project is funded by a portion of the reparation money paid to the state of Alabama by British Petroleum.

Rona organized and chaired a session on trace element geochemistry and biochemistry for the 2010 Goldschmidt Conference, which was held in Knoxville, Tennessee in June. Getting to the conference was a bit more challenging than you might imagine, as immediately preceding the meeting, Rona, Jim and James were in Tulsa, Oklahoma for the President's Cup regional soccer tournament. After James' team, which was the U-17 DII State Champion, played their third game on Saturday, Rona and Jim hit the road and made it to Knoxville by 1:00 PM on Sunday. She and one of her students presented papers at the Conference. She also presented a paper in a carbon sequestration/EOR session at the 2010 Annual Meeting of the Geological Society of America in Denver, Colorado. Rona once again served as acting chair of the Department for most of the summer while Ibrahim Çemen was doing field work in Turkey.

If you recall from the last newsletter, one of Rona's goals for the sabbatical that she took in Spring 2010 was to clean up her office. It didn't happen, as you can witness for yourself if you stop by for a visit. Unfortunately, the stacks of paper are just as high now as they have been for the past several years. She has resigned herself to the fact that she will never have the time required to clean up her office, no matter how many sabbaticals she takes, as there are always other more interesting and important things that need to be done (thank goodness).

## ANDREW GOODLIFFE
### Associate Professor

Andrew Goodliffe currently has five students. Whitney Harris, the newest addition, started her Ph.D. in August 2010. She is working on a Department of Energy (DOE) supported project with a goal of geological characterization of the Black Warrior Basin in Alabama in the vicinity of the Gorgas and Miller power plants. Ultimately this project will assess the potential carbon dioxide storage capacity in the saline reservoirs present in this basin. The project is also supporting Rachael Rutter, who will complete her M.S. in December 2011. Both Rachael and Whitney are busily preparing for the imminent collection of ten miles of reflection seismic data, the drilling of an 8000-foot well, and an experiment that will study microseismicity during small volume water injection. Another ongoing project is a study of the geological evolution of the eastern Gulf of Mexico. Emeka Nwafor, who will complete his M.S. by August 2011, is creating a detailed gravity model of this margin with the goal of trying to shed light on this enigmatic basin. Meghan Alesce, who is also aiming on completing her M.S. by August 2011, is working on the coastal geology of the Alabama Gulf Coast, with particular emphasis on the use of CHIRP and historical coastline data to examine the sand budget along this coastline. Both Emeka and Meghan are supported on research assistantships from BP oil spill money that has been awarded via the Dauphin Island Sea Lab. Meghan's primary responsibility through this funding is the creation of a database of sidecan sonar data for the Alabama continental shelf. Emeka is using 2-D reflection data to study circulation within the water column on the basis of salinity boundaries. Milo Cameron, who is working on his Ph.D., is studying the tectonics of Papua New Guinea with particular emphasis on plate reconstructions and the role of core complexes in active continental rifting.

In the spring of 2010 Goodliffe was funded by the Incorporated Research Institutes for Seismology (IRIS) to scout locations for seismic stations that will be installed as part of the USArray project. Working jointly with Lorraine Wolf from Auburn University two undergraduates joined us at Purdue University in early May for a workshop on locating and installing seismometers. Immediately following this workshop, the undergraduates spent their summer travelling extensively through Alabama and meeting many colorful characters in their search for the best sites. The student's hard work will be rewarded by the greatly improved images of the subsurface of the southeast that will result from this seismometer deployment.

In addition to the numerous research projects discussed above, Goodliffe is an active member of the National Science Foundation (NSF) GeoPRISMS Education Advisory Committee (GeoPRISMS is a research program that focuses on the world continental margins, the host to the majority of our natural resources). As part of this, Goodliffe has helped convene a number of workshops and has recently run education and outreach activates at the subduction cycles and deformation workshop in Austin, TX. Goodliffe is also continuing as a member of the International Ocean Drilling Program Site Survey Panel. This panel is responsible for evaluating proposals to the International Ocean Drilling Program and the suitability of the data available to locating deep ocean drill sites.

## SAMANTHA HANSEN
### Assistant Professor

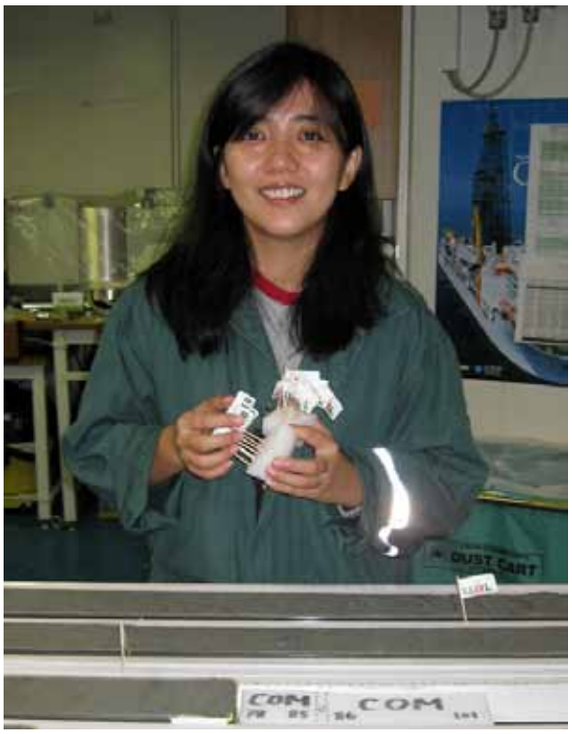
Hired as the new departmental seismologist, I started at the University of Alabama in August 2010. Before this, I obtained my B.S. and M.S. from the University of Wisconsin – Madison in 2000 and 2002, respectively, before heading to the University of California – Santa Cruz, where I obtained my Ph.D. in 2007.

I then moved to Pennsylvania State University, where I worked as a NSF postdoc for about two and a half years.

My research is primarily driven by the underlying goal to advance our understanding of fundamental geodynamic processes, such as volcanism, mountain building, continental rifting, and craton formation. To this end, I employ a wide range of geological and geophysical tools emphasizing earthquake seismology and the analysis of seismic data to investigate structure and infer associated earth processes. Currently, I am working on projects primarily focused in Africa and Antarctica, but I am also developing new collaborations to examine the Gulf of Mexico margin and the Southern Laurentia boundary (between Missouri and Louisiana). In terms of teaching, I am currently leading a section of Geology 101, and I have plans to develop a new Introductory Seismology course for the Fall 2011 semester. I am very happy in my new position and anticipate exciting times ahead.

http://www.as.ua.edu/geo/faculty-staff/hansen-samantha/

## YUEHAN LU
## Assistant Professor




*Yuehan is sampling from the deep sea sediment cores during the IODP expedition 333*

Time has flown since I joined the department of Geological Sciences in the August of 2010. I obtained my Ph.D. in oceanography/ marine geochemistry from the University of Michigan at 2008 and was a Mellon Postdoctoral Fellow at College of William and Mary/ Virginia Institute of Marine Sciences between 2008-2010. My research focuses on the cycles of organic matter in modern and paleo aquatic ecosystems. Two projects have been established since I moved to Alabama. (1) I am collaborating with the colleagues in the Alabama Institutes to understand the effects of the BP deep horizon oil spill on the coastal ecosystems of Alabama. We are investigating the distributions of oil-dispersant pollutants in water column, sediments and food chains. We just made the first field trip along the coast of the Gulf of Mexico in Alabama in February, and we are planning another trip in this March. (2) I joined the IODP (integrated ocean drilling program) expedition 333 science party as an organic geochemist in December 2010–January 2011. Besides taking plenty of tasty seafood, we collected sediment cores from 3000-4000m below the sea surface and drilled the oceanic crust to understand the tectonic history of the Nankai Trough in the western Pacific Ocean (SW of Japan). This project allows me to use biomarkers and isotopes to understand the landslide history and the deep biosphere.

I taught "Sustainable Earth" (GEO 105) in the fall of 2010 and am teaching a new graduate course, "Advanced Environmental Geochemistry", in the spring of 2011. Teaching provides me a great opportunity to interact with students.

My first semester will not be so smooth without the mentoring and support from my colleagues in the department. I have been enjoying my time in Alabama and look forward to a productive year of 2011.

## TIM MASTERLARK
## Assistant Professor

I began the 2010 academic year with an expedition to install seismometers on Hekla volcano, Iceland, with hopes of capturing the seismic signature of the anticipated decadal eruption. The science team for the expedition included UA grad student Sarah Needy, Dr. Matt Haney and Andrew Neis (Boise State University), and Dr. Rikke Pedersen (the University of Iceland's Nordic Volcanologic Center). Although capturing an eruption is our primary goal the seismometers are gathering ambient noise data that we will use to image the internal structure of the volcano in the meantime.

Dr. Matt Haney (Boise State University) and I published a paper in Journal of Geophysical Research that describes how the combination of seismic tomography, InSAR imagery, and numerical deformation models to reveal the internal structure and magmatic plumbing system for Okmok volcano, Alaska. This project recently became more comprehensive with the addition of InSAR and seismology gurus Dr. Kurt Feigl and Dr. Cliff Thurber (University of Wisconsin). As a spin-off of this project, UA grad student Jonathan Stone was awarded a prestigious NASA Earth and Space Science Fellowship (tuition and stipend for 3 years) to develop sophisticated numerical methods to better interpret the InSAR and seismologic data.

The Geodynamics Laboratory's Cray CX1 High Performance Cluster (provided by generous support from the USGS Volcano Hazards Program) is fully operational. This machine (48 cores

The 2004 M9 Sumatra-Andaman Earthquake (SAE) is another ongoing target of my research group. UA grad student Kristin Hughes, along with our colleague Dr. Walter Mooney of the USGS, published two papers (Earth and Planetary Science Letters and Lithosphere) describing how pore fluids in the subducting slab of the SAE migrated and destabilized the adjacent plate boundary, thus triggering the 2005 M8.7 Nias Earthquake. Kristin's work includes the profound conclusion that in the absence of pore fluids in the subducting slab, the 2005 M8.7 Nias Earthquake would have occurred sometime in 2011.

My Geodynamics Laboratory has become an informal, but vibrant, international institution for scientists interested in constructing finite element models (FEMs) of deformational systems. Dr. Wei Tao joined my research group as a post-doc for 2010 and 2011. She is constructing FEMs to investigate the role of pore fluids and potential triggering of the 2008 M8 Wenchuan Earthquake by impoundment of a nearby reservoir. Preliminary results suggest that the reservoir impoundment induced a pore pressure pulse in the crust that slowly migrated away from the reservoir and destabilized the fault of the Wenchuan Earthquake, thus accounting for the proximity of these two events in both space and time. A manuscript of this work was submitted to the Bulletin of the Seismological Society of America. Sherwood Wang (Hong Kong Polytechnic) and I have a 100% virtual collaboration to study the 2009 M7.3 Yutian Earthquake, China. This project culminated in a manuscript submitted to Geophysical Journal International. Visiting Ph.D. students Christodoulos Kyriakopoulos (INGV-Rome, Italy) and Erika Ronchin (University of Barcelona, Spain) joined my research group over the past several months to construct FEMs for earthquakes and volcanoes, respectively. Erika's visit will continue through this summer. Christodoulos has since returned to Italy, and he is sorely missed. Jay Tung and Dr. Lung Chan (Hong Kong University) will visit my Geodynamics Laboratory for a few weeks later this spring to discuss the analysis of postseismic gravity measurement campaigns for the M8 Wenchuan Earthquake. Lung was my undergraduate advisor, mentor, and friend and he is largely responsible for everything that has happened to me since 1991.

*The road to Hekla Volcano, Iceland.*

and 144 GB RAM + a planned expansion later this spring) is designed to execute complex finite element models and opens the door to new ideas and simulations that were simply out of reach only a few short months ago. Last, but not least, I am pleased to report that Haylee Dickinson graduated from UA with an MS in December, 2010. Haylee has gone on to pursue a Ph.D. at Purdue University. For more information about the Geodynamics Research Group, go to: www2.geo.ua.edu/faculty/TMweb/Masterlark.html.

## ALBERTO PÉREZ-HUERTA
### Assistant Professor

More than a year has passed since my appointment at the end of 2009 and I am still as enthusiastic about this new adventure in academia as when I started. My research activities have expanded considerably with new research projects and collaborations. To cite few examples, I have established new collaborations with Drs. Ben Passey (Johns Hopkins) and Ethan Grossman (TAMU) to study clumped isotope thermometry and crystallography in carbonates, Dr. Sally Walker (University of Georgia) to work on scallops from Antarctica for paleoenvironmental reconstructions, and with Dr. Conchita Jiménez (Universidad de Granada, Spain) to study biomagnetite from bacteria. In terms of ongoing projects, I continue to work with Dr. Fred Andrus in the study of bivalves from Peru and their relationship to El Niño and we are currently involve in a project to analyze the impact of the Gulf of Mexico oil spill on oyster shells and their recovery. As a novelty this year, I have my first two graduate students, Brittany Hollon (M.Sc.) and Lynn Harrell (Ph.D.). Brittany is going to Spain in May to conduct fieldwork for the study of Lower Jurassic rhythmic sequences and Lynn is starting a project, with the help of Dr. Jim Parham (Alabama Museum of Natural History), to analyze different aspects of Late Cretaceous vertebrate faunas from Alabama. Finally, I have to mention that I was appointed as Assistant Curator of Paleontology in the Alabama Museum of Natural History and as affiliated faculty to the Center for Materials for Information Technology (MINT) at The University of Alabama.

## DELORES ROBINSON
### Associate Professor

My major accomplishment over the past year was to earn tenure and I'm looking forward to my sabbatical during the 2011-2012 academic year! I am finishing my 7th year with the department. Over the past year, my research efforts have concentrated on the Eastern Gulf of Mexico and the Himalaya of Nepal and India. Two M.S. students, Lance Wilson and Bryan Hunt, are working on understanding the opening of the Eastern Gulf of Mexico and deposition of reservoir rock in Mesozoic time. These students will be presenting at the Houston AAPG meeting in April – if you are going to be there, stop by and check out our work. Two Ph.D. students, Subodha Khanal and Subho Mandal, are working

on the tectonic evolution of central Nepal and northwest India. The Gulf of Mexico work is funded by industry companies who are interested in the early history of the region. The work in India is funded by the U.S. National Science Foundation. I gave four presentations at conferences last year and that was a lot of work! I taught The Dynamic Earth in fall of 2010 and am currently teaching a graduate class Petroleum Systems and Structural Geology. Many of our students go on to work in the industry so I help to give them a solid background in interpretation and mapping of structural systems. I took on a new role this year, that of lab coordination for the 2000 or so students we circulate through the introductory geology class, The Dynamic Earth. I work closely with the TA's to mentor them in teaching their classes and continually update the lab manual for the class, which members of the department wrote two years ago.

## JOSHUA SCHWARTZ
### Assistant Professor

This past year has been exciting for UA Igneous Petrology! Two new M.S. graduate students (Ryan Jeffcoat and Stan Ingram) have joined the Igneous Petrology research group which currently including myself, M.S. student Scott Anderson, and undergraduates Scott Milo and Raya Greenberger. I'm very impressed with all of the tremendous strides that they have made in their M.S. research!

New graduate student Ryan Jeffcoat has already amassed a large amount of data from research trips to the University of Florida and Stanford University. His research focuses on the magmatic construction of lower oceanic crust exposed on Macqurie Island (Southern Ocean) and involves using U-Pb and Hf isotopes in zircon to understand the timescales of oceanic crustal construction and the different mantle reservoirs that are melted during seafloor spreading. His work will have great impact on our understanding of heterogeneous mantle sources in the Earth's mantle. We plan to present his work at the American Geophysical Union Annual meeting in December, 2011.

Closer to home, graduate student Stan Ingram is working on the tectonic and magmatic development of the Eastern Blue Ridge in Alabama. Stan's work also uses U-Pb zircon geochronology, Hf isotopes and whole rock geochemistry to investigate the origin of deep crustal (>35 km) partial melts that formed during the NeoAcadian orogeny at approximately 350 to 330 Ma. His work places important constraints on the timing of magmatism in Alabama, which until this point was not well known. Stan and I will be presenting this work at the Geological Society of America Northeastern meeting in Pittsburgh in March, 2011.

Finally, Scott Anderson continues to make great progress in understanding the timing of magmatism, deformation and metamorphism in the Blue Mountains province, in Northeastern

*M.S. students Scott Anderson (top) and Ryan Jeffcoat (bottom) hunt for fresh samples of the Diorite of Alexander Creek in the Mountain Home Metamorphic complex, Blue Mountains Province, NE Oregon. Photo taken in July, 2010.*

*M.S. students Scott Anderson (back) and Ryan Jeffcoat (front) collect Hf isotope data on igneous zircons at the University of Flordia in January, 2011.*

*M.S. students Scott Anderson triumphantly collects a sample of the 'Gabbronorite of Ridenor Canyon' after hours of searching for the perfect sample for geochronology. Scott successfully performed U-Pb zircon geochronology on the sample at Stanford in November and determined its age to be 145 Ma.*

Mountains between 150 to 148 Ma. The timing of this event is similar to the so-called 'Nevandan orogeny' in the Klamath Mountains in northern California and suggests that there may be a link between these two geologic provinces. This work will have great impact on how we think about the tectonic development of northeastern Oregon! Scott and I will be presenting his work at the Geological Society of America Cordillerian/Rocky Mountain meeting in Logan (Utah) in May, 2011.

## HAROLD STOWELL
### Professor

My teaching efforts during the last year focused on Mineralogy, Field Course, graduate-level Metamorphic Petrology, Regional Geology, and Ore Deposits. The first three classes are taught either each year or every other year. Regional Geology was co-taught with Joshua Schwartz as an undergraduate and graduate student seminar with a field trip. The class embarked on a ten day adventure "Craton to Accreted Terranes: An Overview of Pacific Northwest Geology" (http://www2.geo.ua.edu/fieldtrip_2010/Templates/main.html). This trip, which was partly funded by the University of Alabama and the National Science Foundation, provided a unique opportunity for University of Alabama students to see the collage of accreted terranes and evidence for the currently active plate margin (Mount Saint Helens). During summer 2010, I directed and co-taught the summer field course in northern New Mexico and southern Colorado. As always this class provides a challenging and rewarding educational capstone for our undergraduate students. Ore Deposits had not been taught at Alabama since Michael Lesher departed the University in the late 1990s. This class, which is now in progress, is back by popular (student) demand and provides experience with the tools used by industry to provide raw materials to society.

My research efforts continue to move forward in the areas of tectonics, petrology, and geochronology. I published a paper "Timing and duration of garnet granulite metamorphism in magmatic arc crust, Fiordland, New Zealand" in *Chemical Geology*. I supervised undergraduate, M.S., and Ph.D. students doing research on metamorphism of pelitic rocks from the Cascades of Washington [B.S.G. Robert Tootle, Dec 2010*], pressure-temperature-time paths for amphibolite from the Salmon River Suture zone of western Idaho [M.S. Matthew McKay], nucleation and growth history of garnet porphyroblasts from Townshend Dam Vermont [Ph.D. Matthew Gatewood], and the timing, pressure, and temperature of garnet growth in lower crustal rocks of Fiordland New Zealand [M.S. Karen Odom Parker, Dec 2010*]. These projects utilize field observations, rock textures, mineral compositions, thermodynamic models, and isotope geochronology to better understand the large-scale processes of mountain building, accretion of magmatic arcs to continents, and the lower crustal structures that accommodate extension during orogenic collapse.

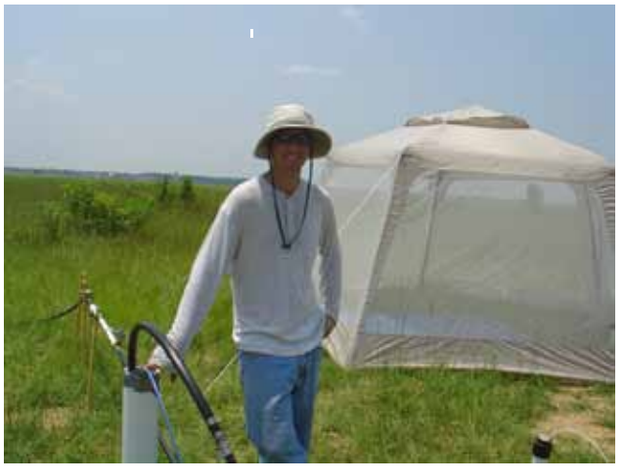
* Indicates date of degree completion.

## GEOFFREY R. TICK
### Associate Professor

It's been a busy and productive year in contaminant hydrogeology! I had a very productive semester-long (Fall 2010) sabbatical spending time on research projects in Arizona at the Department of Energy's (DOE) Monument Valley Uranium Mill Tailing Site (MVUMT) and at the University of Arizona Contaminant Transport Laboratory. My colleagues and I just finished a 5-month long enhanced natural attenuation remediation project at the MVUMT site. This research involved utilizing cosolvent mixtures to enhance the degradation of nitrate contamination in the aquifer at this DOE legacy site. Research was also initiated at the University of Arizona investigating the performance of field-scale enhanced-flushing techniques for the remediation of aquifers contaminated by hazardous organic immiscible liquids. The MVUMT site research has already led to the submission of a manuscript to the *Journal of Contaminant Hydrology*, a top ranked journal in the field. A manuscript from the research at the University of Arizona's Contaminant Transport Laboratory (i.e. performance of enhanced flushing techniques) is currently being prepared for publication and will be submitted this spring to *Environmental Science and Technology*, a top ranked journal in the field.

Additional accomplishments over the past year include a first-authored paper published in the journal *Ground Water*, two co-authored papers published in *Ground Water*, one co-authored paper published in *Water Resources Research*, and one first-authored paper currently under review in *Environmental Science and Technology*. I currently have a NSF research proposal under review and I have been working with the BP/UA Gulf of Mexico Group to submit funding proposals to study effects of the BP oil release that occurred over the past year.

*Pore-Scale Research: Quantifying oil recovery processes during surfactant flooding; Advanced Photon Source Synchrotron Facility, Argonne National Laboratory.*



*Field-Scale Research: Characterizing small-scale preferential flow paths in a highly heterogeneous aquifer, Columbus Air Force Base, Mississippi.*

*Photos above and below: Field Scale Remediation Project at DOE Monument Valley Uranium Mill Tailing Site: Monitoring the injection of ethanol and tracer and sampling nitrate concentrations in the aquifer.*

I have been continuing my research interests in many different areas including 1) investigating oil recovery processes at the pore scale; 2) conducting regional scale studies of saltwater intrusion, nitrate fate and transport, and groundwater flow dynamics of the aquifer system of southern Baldwin County, Alabama; 3) investigating field-scale innovative techniques to characterize small-scale preferential flow paths in highly heterogeneous aquifers: Columbus Air Force Base, Mississippi; and 4) investigating the processes controlling the dissolution and removal of multi-component immiscible liquids at different scales.

I have recently welcomed new graduate students, Samuel England, Alex Huang, and William Burke to my program over the last year. I currently advise/co-advise six graduate students working on research projects under my direction; five M.S. students (Alex Huang, Samuel England, William Burke, Jason Harvell, and David Slavic) and one Ph.D. student (Jaydeep Ghosh). Dorina Murgulet, who graduated with her Ph.D. in my program in 2009, continues to work at the Geological Survey of Alabama as a hydrogeologist. In addition, I am currently advising two undergraduate students (Jennifer Leonard and Jerad Tate) on research projects in my laboratory.

I am excited about teaching a new set of eager students in my Geology 410/510 “Soil and Groundwater Restoration” and Geology 101 “The Dynamic Earth” courses this semester (Spring 2011) and look forward to teaching Geology 306 “Hydrogeology” next semester (Fall 2011). This year I have seen some of the largest enrollment increases in my courses which provide me the rewarding opportunity to inspire these students to become future hydrogeologists!!

## CHUNMIAO ZHENG
## George Lindahl III Endowed Professor of Hydrogeology

After a record-setting lecture tour in 2009 that took me to 70 universities and research institutions in four continents as the Birdsall-Dreiss Distinguished Lecturer for the Hydrogeology Division of the Geological Society of America, I was looking forward to a relatively calm and quiet 2010. However, things didn't turn out quite the way as I had envisioned. I continued to travel frequently in 2010 both for collaborative research projects and for work arising from a dual appointment at Peking University in China.

A highlight of my activities in 2010 was the organization of an international symposium called "International Groundwater Forum 2010" on July 7-8 in Beijing, China. Over 100 researchers and students from China, United States and Europe gathered to discuss the challenges and opportunities in groundwater research and to promote the collaboration between Chinese and international researchers in groundwater and related fields. The forum was prominently featured by the journal Nature under the title "China Faces up to Groundwater Crisis," which attracted a lot of media attention.

Another highlight for 2010 was my appointment to the George Lindahl III Endowed Professorship by the University of Alabama Board of Trustees in September. The professorship was made possible by a generous gift from Mr. George Lindahl III, a graduate of the Department. I am deeply grateful to Mr. Lindahl III for his generosity and to the UA colleagues and administrators for bestowing the honor on me.

Within my research group, Dr. Rui Ma, a post-doctoral research fellow over the past two years, was appointed a research assistant professor starting in January. Rui has been doing an outstanding job conducting hydrologic, heat and geochemical modeling studies at the Hanford site in Washington as part of the DOE supported "Integrated Field Research Challenge (IFRC)" project. Marco Bianchi completed his Ph.D. degree after four years of stay at Alabama. Marco's dissertation was a field and numerical study of solute transport processes at a well-known tracer test site in Columbus, Mississippi as part of a NSF supported research project. He has now returned to Italy with his wife and their beautiful daughter born in Tuscaloosa. A new student Alex Huang jointed our group in the fall after getting his BS degree from Purdue. Three continuing students, Guoliang Cao, Li Huang and Jessa Moser are all working hard toward the completion of their degrees.

## STAFF

**Darlene Capps** I cannot believe that another year has started for us again! We have welcomed new faculty and students who are a great value to DGS. I respect and appreciate the dedication and commitment that all show to UA and DGS.

**Betty Fagen** Being a part of the Department of Geological Sciences for over 8 years, I am honored to work with the professors and students. The geological sciences offer such interesting and knowledgeable concepts of our world through the ages and on into the future. Our department has grown immensely in the past 2 years with many new graduates and faculty, we are expecting additional faculty this Fall.


*Betty with Big Al at the UA Couch to 5K program on campus.*

**Debbie Frank** This is Debbie's 20th year working in the department of Geological Sciences. She works with everything financial. While she enjoys her job immensely, it can get stressful at times. Her job is never boring as UA changes their policies and procedures often. It keeps her on her toes. She works with a diverse group of people and has a variety of duties. Luckily for her, everyone gets along well.

**Diane Norris** Working for the past 15 years in the Department of Geological Sciences has been quite interesting. This year we posted a new look for our website and it has received very positive comments. It took input from the entire department to present a comprehensive view of our mission. The website is a work in progress as our department goes through positive changes. I am excited about the future for our department and how the interest in earth sciences is expanding. Roll Tide!

# From our Emeritus

## CARL STOCK

Things have progressed during retirement. Judy and I spent nearly half the year in Colorado in 2009 and 2010, and have determined we will not go back until our house in Northport is on the market. As many of you probably know, the University of Alabama has increased undergraduate enrollment by about 12,000 students in the past few years. Now additional faculty are being hired to serve these students, and so I must clear out of my office and lab this spring, to make room for our new faculty. Consequently, our spring 2011 semester is a busy one.

My last doctoral student, Sandy Ebersole, defended her dissertation, "Biostratigraphy, paleogeography, and paleoenvironments of the Upper Cretaceous (Campanian) northern Mississippi Embayment" in December 2009; she graduated in May 2010. My last master's student, Jeff Aul, defended his thesis, "Stromatoporoids and the Upper Devonian Alamo Impact Breccia in southeastern Nevada" in May 2010; he graduated in August 2010. Sandy has worked for the Geological Survey of Alabama for several years. Jeff, after a few years of advising varsity student athletes, and having risen to coordinator of all athletic advising, took a job this January with the Alabama Department of Environment Management in Montgomery.

Several publications have appeared since I last wrote. Among these is a monograph entitled "Late Ordovician and Early Silurian Stromatoporoid Sponges from Anticosti Island, Eastern Canada: Crossing the O/S Mass Extinction Boundary," which was published by the National Research Council of Canada Press. Two co-authors on this publication are Heldur Nestor, who has retired from the Institute of Geology of Tallinn Technical University in Estonia, and Paul Copper, who has retired from Sudbury University in Ontario, Canada—a lot of retirement going on it seems. A second publication is a chapter in Treatise Online, which is the online version of the Treatise on Invertebrate Paleontology, entitled "A list of upper Paleozoic-Mesozoic stromatoporoid-like genera; and excluded taxa," with co-author Colin Stearn who is retired from McGill University in Montreal, Quebec, Canada—yes, yet another retiree. All the people in North America who study stromatoporoids are retired, representing a metaphorical endangered species. I plan to continue my stromatoporoid research as long as my mind cooperates.

# Memorable Photographs


Students at the Imperial Barrel Awards (IBA) competition, hosted by GCAGS, at Schlumberger's downtown office in Houston, TX. Left to right; Ted Godo (industry advisor), Matt Mckay, Jeff Fuchs, Whitney Harris, Rachael Rutter, Lance Wilson, (graduate students), Delores Robinson (academic advisor).

*Top photo.*

*Students and faculty pose on a grassy outcrop of the Elkahatchee Quartz Diorite near Alexander City, AL. Department of Geological Sciences field trip ca. 1990.*

*Middle photo.*

*Students and faculty observe tightly folded layers of marble being quarried near Sylacauga, AL. Department of Geological Sciences field trip ca. 1990.*

*Lower Photo.*

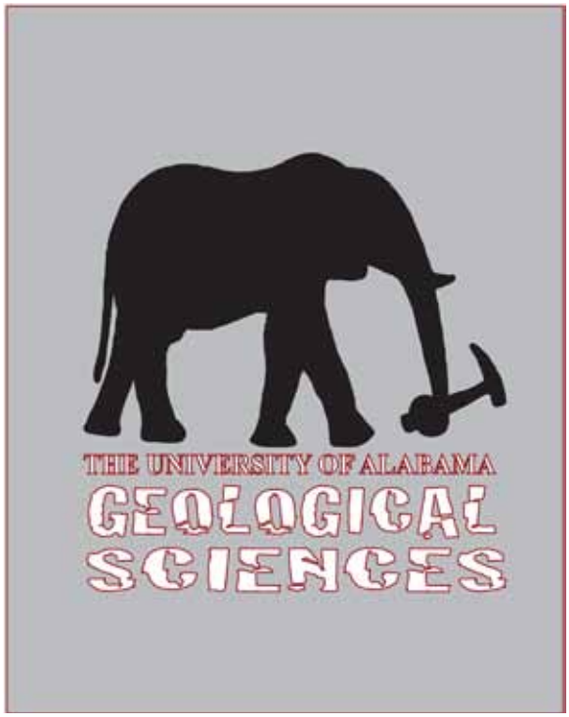
*Students and faculty examine the Precambrian Whatley Mill Gneiss in Chewacla State Park,AL. Department of Geological Sciences field trip ca. 1990.*

# T-shirts anyone?

**Gray short sleeve T-shirt with "A" on left front chest and "elephant with rock hammer" on back.**

## Front design

## Back design




**Three of our graduate students worked together to produce this T-shirt. The design was created by Matt McKay and Rachael Rutter. The production was overseen by Meghan Alesce. Many thanks to them.**

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