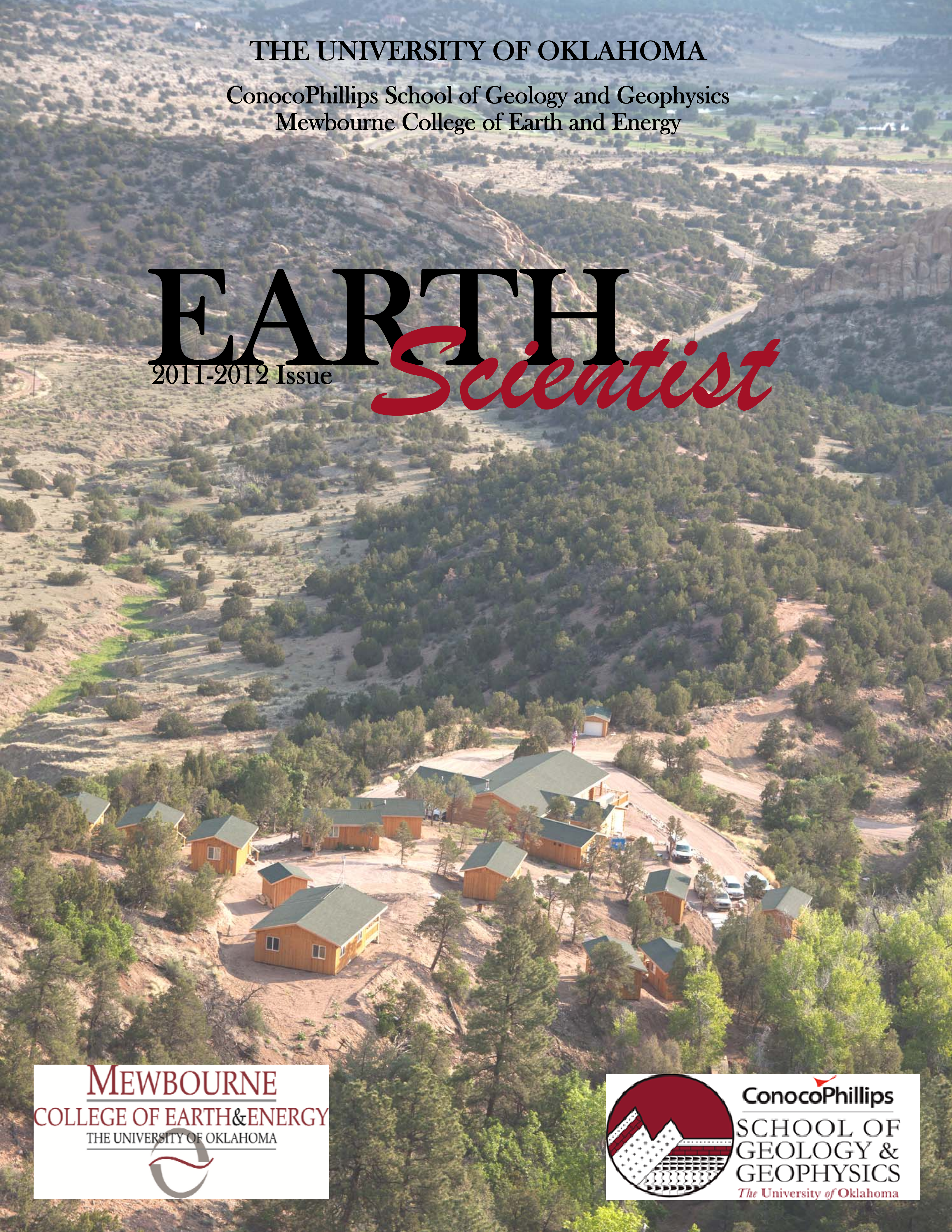
THE UNIVERSITY OF OKLAHOMA

ConocoPhillips School of Geology and Geophysics
Mewbourne College of Earth and Energy

EARTH *Scientist*

2011-2012 Issue



MEWBOURNE
COLLEGE OF EARTH & ENERGY
THE UNIVERSITY OF OKLAHOMA

ConocoPhillips
SCHOOL OF GEOLOGY & GEOPHYSICS
The University of Oklahoma

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Many thanks to the students, faculty and alumni who graciously contributed articles, photos and facts to the making of this magazine...without you, there would not be an Earth Scientist!

ConocoPhillips School of Geology and Geophysics Vision Statement

The ConocoPhillips School of Geology and Geophysics shall be a preeminent center of excellence for study and research in geology and geophysics, with emphasis in applied areas such as energy. Students shall be provided with a high-quality education that stresses the fundamentals of science within a creative, interdisciplinary environment and that prepares them for success in their professional careers by instilling knowledge, skills, confidence, pride, principled leadership, and the ability to contribute to the wise stewardship of the earth and its resources.

About the Cover

The ConocoPhillips School of Geology and Geophysics' new Bartell Field Camp in Cañon City, CO.

The Earth Scientist is published annually, reporting on research, activities and programs related to OU's ConocoPhillips School of Geology and Geophysics. It is prepared and distributed with private funds at no cost to the taxpayers of the State of Oklahoma. Please address all inquiries and changes of address to Teresa Hackney, ConocoPhillips School of Geology and Geophysics, 100 East Boyd St, 710 Sarkeys Energy Center, Norman, OK 73019-0628.

EARTH *Scientist*

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Director's Corner

Doug Elmore

The faculty, students and staff in the ConocoPhillips School of Geology and Geophysics had another successful and eventful year and I am pleased to report that we filled both positions: Matthew Pranter (petroleum geologist) and Jamie Rich (geophysicist). I will provide more details on each of them at the AAC meeting and in the next Earth Scientist. We offered our geology and field geophysics courses for the first time at our new "Bartell Field Camp" last summer. The dedication of the camp was on June 11, 2011, and was a big success. See the article in this issue for more details. You can also check the field camp Blog for updates and pictures from the dedication event (http://faculty-staff.ou.edu/E/Richard.D.Elmore-1/blog/Doug_Elmores_Field_Camp_Blog/). The school also was reviewed by the university academic program review committee and received a very good review.

Our graduate and undergraduate enrollments are healthy and continue to increase. We now have more than 105 graduate students and over 140 undergraduate majors. We awarded more undergraduate scholarships and we increased the scholarship amounts from last year. On average, CPSGG faculty teach more than 500 credit hours/year, which is equal to about 167 students in three credit courses. This compares very well with many other units at the university. In addition to the courses we teach for our majors, we teach more than 1,500 students in introductory general education courses. The faculty also were successful in terms of research, with about $2.5 million in research expenditures during the last year.

One challenge we will be dealing with in the next five years is the potential for faculty retirements. Eight faculty will be able to retire in the next five years. This is one reason the faculty searches for this year are so important. Another challenge we will be facing is the university's continuing tight budget.

Other notable events:

- We have a new website (geology.ou.edu) that went active in the fall of 2011.
- At our spring picnic and honors event, Rebecca Johnson received the Charles N. Gould Award, Tad Eccles received David W. Stearns Award, John Leeman received the Alan Witten Award and Daniel Ambuehl received the Estwing Hammer award. Jordan Myers received the Stan Cunningham Outstanding Teaching Assistant Award. Seth Gainey and Earl Manning received a Ben Hare Research Prize for M.S. students. The staff awarded the "Student Rock Award" to Andrea Cadena Mendoza and Brett Schlichtemeier.
- Five students placed second in the regional Imperial Barrel Competition. Team members included Sarah Farzaneh, Yoryenys Del Morro Pernia, Yuqi Zhou, Jordan Myers and Gaurang Patel (with help from Alfredo Fernandez). Their adviser was Larry Grillot.
- Last fall, more than 27 companies interviewed on campus, and our students continue to get good jobs. The AAPG-SEG Spring Break Student Expo event was successful, with 160 students attending. Brett Schlichtemeier and Murari Khatiwada won first place at the regional SEG Challenge Bowl competition and will represent the school in the SEG meeting this year.
- In May, Barry Weaver, Gail Holloway, Lynn Soreghan and I ran the freshman field trip to New Mexico and Colorado. Sixteen geology and geophysics students had the chance to spend two days at the Bartell Field Camp.

AAC Update

Sharon Minor
Devon Energy
Chair 2011-2013

Greetings everyone from the Alumni Advisory Council! I look forward to serving as your chair for the next two years. Also serving as officers of the Council are Brad Biddy (Devon Energy), vice chair, and Tommy Craighead (T.D. Craighead Oil and Gas Investments), secretary. This has been an exciting year!

During the April 2011 meeting, the council nominated a committee to explore options to assist the university with funding priorities for the school, which could include additional petroleum geology faculty positions, new lab equipment and support for field trips. There continues to be funding pressures for public universities, and the Alumni Advisory Council wishes to help the university identify additional revenues for the ConocoPhillips School of Geology and Geophysics.

Also at the April 2011 meeting, Doug Elmore, director of the ConocoPhillips School of Geology and Geophysics, announced the opening of the new Bartell Field Camp. Doug mentioned that several naming opportunities are still available for those who wish to make a donation to the Field Camp Fund. As I write this letter, the school currently is conducting its second class at field camp.

We also learned that the school had two vacant faculty positions, one for a petroleum geologist and one for an exploration geophysicist, both of which have since been filled.

In November 2011, Dean Larry Grillot addressed a joint meeting of the Mewbourne College of Earth and Energy's Board of Visitors, the ConocoPhillips School of Geology and Geophysics Alumni Advisory Council, and the Mewbourne School of Petroleum and Geological Engineering Industry Advisory Board. Grillot stated that enrollment continues to grow for the college and discussions are under way to increase the GPA for admission to the college from 2.00 to 2.50 to help ensure that only students most likely to succeed are admitted to the college. Along with the change in GPA, several ideas have been discussed to manage enrollment, including admission and retention requirements, and being rigorous about prerequisites. These changes would affect both schools.

Exciting things are happening for our school, so let's keep it moving forward!

Boomer Sooner!

Letter from the Dean

Larry Grillot

This year saw the passing of geology alum Cy Wagner Jr. It was my privilege and honor to present Cy with our Distinguished Alumni award last year, and his generosity to the university has benefited many students and will continue to be felt by many future students. His dedication to OU was never more apparent than at the end of his memorial service, when the OU band marched out of the church to "Boomer Sooner." Cy Wagner will be missed not only by the OU family, but by the broader community.

As I noted in the 2011 edition of the *Earth & Energy Magazine,* our student enrollment has increased from 460 in 2006 to more than 900 in fall 2011. While this dramatic increase presents both opportunities and challenges, I believe you will see in this edition of *The Earth Scientist* that the ConocoPhillips School of Geology and Geophysics continues to move forward. *The Earth Scientist* highlights the variety of activities in the school, both faculty research and student accomplishments.

We are now seeing the real benefits of the improvements of the past five years, including faculty and student areas, the remodeled Youngblood Library, new computer labs, and remodeled office and student project spaces in the Energy Center complex.

Our students continue to excel, and we have strong recruitment of our graduates by a broad range of companies, and many of our graduates are also successfully continuing with graduate education or pursuing careers in academia.

At the past joint meeting of the Board of Visitors, Alumni Advisory Council and Industry Advisory Board, I highlighted both the accomplishments of the past five years and the challenges/issues facing the college for the next five. And while the challenges are significant, with the continued support of our alumni and key industry supporters, the college is in good shape to meet the needs of our students while building for the future. I look forward to working with you to meet these challenges.

I hope you enjoy the 2011-2012 edition of *The Earth Scientist.*

Development Update

By Ameil Shadid

So, what is next?

Since the Mewbourne College was formed in 2006, we have seen our enrollment double, going from 460 students in 2006 to more than 900 this year. We have successfully completed a capital campaign focused on providing resources for our students and faculty, as well as targeted funding for scholarships, graduate fellowships and capital projects like the Bartell Field Camp. Many thanks to our alumni and friends, who have played a key role in helping us achieve our $82 million college fundraising goal and ensuring that we have a solid foundation for the future.

So, what is next? What will the next five years bring? As I mentioned, we have a solid foundation, thanks to many of you. We now must look for ways to continue to provide the support needed to ensure that our foundation remains strong for generations to come. That will require us to look to explore additional avenues for support. For example, can we lessen the burden for a student to participate in Field Camp by offering scholarships to offset the cost? I believe that should be a goal for us over the next five years.

We anticipate that our enrollment will continue to grow, and that will impact our fundraising efforts and priorities as well. We'll look to use our endowment wisely and add annual gifts that help us address our key needs, both at the college and the school level. Our goal is, of course, to keep costs as stable as possible for our students.

The priorities for support remain basically the same. They include graduate fellowships/teaching assistantships, support for field work, laboratories, and unrestricted support for Doug Elmore, director, ConocoPhillips School of Geology and Geophysics. Unrestricted support is going to be a critical need as we move forward in the coming years. It will allow Dr. Elmore to invest in priority programs and in bright, talented students, who might not have other options for support.

By now, you should have received your annual fund information. You'll notice that you have the opportunity to restrict your gift to the ConocoPhillips School of Geology and Geophysics. If you haven't already done so, please consider making a gift and helping us achieve our goals. It has been a great five years, and we are excited about the future.

As always, if you'd like to contact me regarding supporting CPSGG or if I can be of help in any way, please contact me at (405) 325-3821 or shadid@ou.edu.

Faculty 2011

R. DOUGLAS ELMORE

Director, ConocoPhillips School of Geology and Geophysics

Eberly Chair Professor and Associate Provost

Sedimentology, Diagenesis, and Paleomagnetism of Sedimentary Rocks

KATIE KERANEN

Assistant Professor

Teaching and Research: Seismology and Continental Dynamics

YOUNANE ABOUSLEIMANN

Director, PoroMechanics Institute

Larry Brummett/ONEOK Chair Professor

Mechanics of Porous Media

DAVID LONDON

Norman R. Gelphman Professor, Stubbman-Drace Presidential Professor, and Director, Electron Microprobe Laboratory

Teaching and Research: Economic Mineralogy, Experimental Geochemistry, Igneous and Metamorphic Petrology

MICHAEL H. ENGEL

Clyde Becker, Sr. Chair Professor

Organic Geochemistry

RICHARD LUPIA

Assistant Professor, Assistant Curator of Micropaleontology and Paleobotany, Sam Noble Museum of Natural History

Teaching and Research: Paleontology and Micropaleontology

G. RANDY KELLER

Director, Oklahoma Geological Survey; Edward Lamb McCullough Chair Professor

Lithospheric Structure and Evolution, Integrated Geological and Geophysical Studies, Geoinformatics

ANDREW S. MADDEN

Assistant Professor

Teaching and Research: Low-temperature Geochemistry and Clay Mineralogy

MEGAN ELWOOD MADDEN

Assistant Professor

Teaching and Research: Earth and Planetary Geochemistry

JOHN D. PIGOTT

Associate Professor

Teaching and Research: Basin Analysis and Seismic Stratigraphy

KURT J. MARFURT

Frank and Henrietta Schultz Chair and Professor of Geophysics

Teaching and Research: Seismic Processing, Seismic Interpretation, Reservoir Characterization

ZE'EV RECHES

Professor

Teaching and Research: Structural Geology, Earthquakes, and Rock Mechanics

SHANKAR MITRA

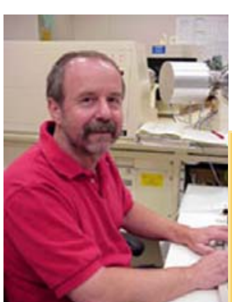
Professor and Victor E. Monnett Chair in Geology and Geophysics

Teaching and Research: Structural Geology

ROGER M. SLATT

Professor; Gungoll Family Chair; Director, Institute of Reservoir Characterization

Teaching and Research: Petroleum Geology, Reservoir Geology, Clastic Sedimentology, and Sequence Stratigraphy



R. PAUL PHILP

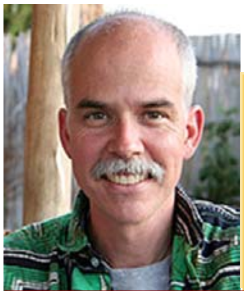
Professor; Joe and Robert Klabzuba Chair; George Lynn Cross Research Professor

Teaching and Research: Petroleum and Environmental Geochemistry

G.S. "LYNN" SOREGHAN

Brandt Professor

Teaching and Research: Stratigraphy and Sedimentology



MICHAEL SOREGHAN

Assistant Professor

Teaching and Research: Sedimentology

STEVE WESTROP

William L Miller Professor
Curator of Invertebrate Paleontology, Sam Noble Oklahoma Museum of Natural History

Teaching and Research: Invertebrate Paleontology

BARRY WEAVER

Associate Dean, Associate Professor

Teaching and Research: Trace Element Geochemistry of Igneous and Metamorphic Rocks

Emeritus Faculty

M. CHARLES GILBERT

Emeritus Professor

Igneous and Metamorphic Rock Systems

JUDSON AHERN

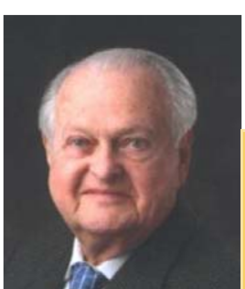
Emeritus Professor

Geomechanics, Gravity and Magnetics, Environmental Geophysics

CHARLES HARPER

Emeritus Professor

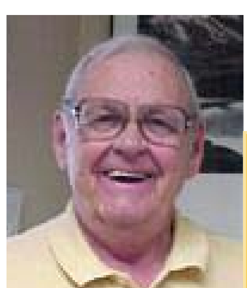
Paleontology



JAMES FORGOTSON, JR.

Emeritus Professor

Petroleum Geology and Basin Analysis



DAVID STEARNS

Emeritus Professor

Structural Geology and Tectonophysics

Cooperating Faculty

RICHARD CIFELLI

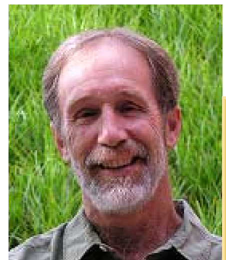
Associate Professor, Department of Zoology; Adjunct Professor, School of Geology and Geophysics

Vertebrate Paleontology
Curator, Sam Noble Oklahoma Museum of Natural History

GEORGE MORGAN

Adjunct Professor, Research Scientist II, Electron Microprobe Lab

Electron Microscopy and Microanalysis, Experimental



NEIL SUNESON

Adjunct Professor, Geologist IV
Oklahoma Geological Survey

Stratigraphy, Petroleum Geology, Summer Field Camp

Administrative Staff

From Left, top row: Steve Holloway, Nancy Leonard, Donna Mullins, Lisa Vassmer. *From Left, bottom row:* Jocelyn Cook, Gail Holloway, Adrianne Fox, Teresa Hackney

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Distinguished Performance Staff Award

Geology and Geophysics' very own Robert Turner was selected by the Informational Staff Association for the 2012 Distinguished Performance Staff Award. This honor is only given to three employees campus-wide each year, and candidates for the selection are brought before the board by nominations by faculty and directors. Robert far exceeds the qualifications for this award and was nominated by a large number of faculty for his outstanding accomplishments.

Some of the thoughts shared about Robert are:

"Robert is personable and charming and a pleasure to work and interact with, and ...I can think of no more worthy a recipient of the Staff Merit Award than Robert."

"Personally, he is just a pleasure to have around the school."

"I have known Robert since his arrival in the ConocoPhillips School of Geology and Geophysics, and have always been impressed with his responsiveness, competence, initiative and pleasant personality."

Robert has been with the department since 2001, and in that time has proven to be an invaluable member of our family. He fulfills a multitude of roles in our school that keep the offices, classrooms, labs and field camp all running safely and smoothly. Robert is known for being a positive personality to work with, no matter the task at hand or the stress level of the situation.

Robert also is very generous with his time outside of the university. He belongs to an Oklahoma City group that helps hearing-impaired individuals and families. Robert is an instrumental part of the group, working with people to help them however he can, from assisting them in finding specialists, to teaching sign language, to answering even the simplest of questions.

We are very proud to have Robert as a part of our school and are honored to work with someone who shines so brightly in their position.

Congratulations, Robert!

Dedication of new Bartell Field Camp

Geology and Geophysics students attended the new Bartell Camp in May and June of 2011. The camp was dedicated on June 11. The day started with a continental breakfast and tours of the camp. At 12:30, lunch was served, followed by the official ceremony. Director Elmore gave a brief history of the camp, introduced the guests, donors, staff and students, and then thanked the many people who made the camp possible, especially Denny and Dixie Bartell, the primary donors. Denny was a “prime mover” in establishing the camp. After he and Dean Larry Grillot made some comments, the group proceeded to the ribbon-cutting at the gate. Copies of the official camp T-shirts remain available for purchase.

Top: Students celebrate the opening of the camp at the gate.

Bottom: The ribbon-cutting at the camp gate of the Bartell Field Camp: from left under sign, Dean Grillot, Provost Mergler, Denny Bartell, Dixie Bartell and Doug Elmore.

Left: The ceremony in the dining hall.

Below: Larry Grillot, Curtis Mewbourne and Chris Cheatwood. Curtis flew Larry and Judy Grillot and Nancy Mergler out to Cañon City for the day. Chris Cheatwood was a major supporter of the camp from its inception.

Photos by Shevaun Williams

Above*:* Denny and Dixie Bartell at the gate.

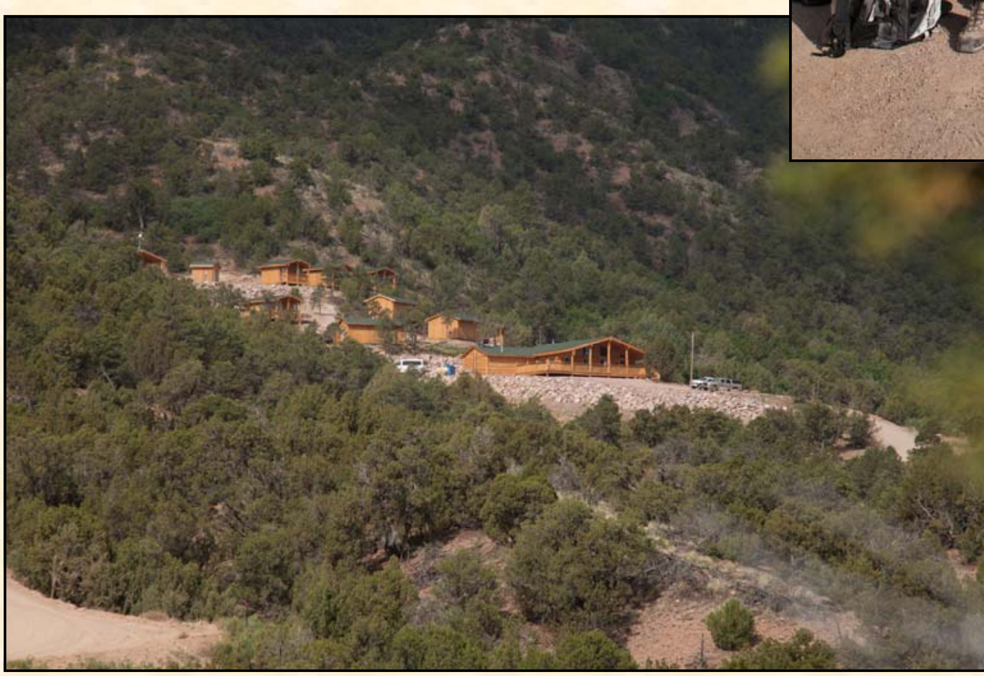
Right: Students, faculty and staff gather on the deck of the dining hall. Thirty students attended the dedication of the camp. In addition to the geology camp (taught by Neil Suneson and Tom Stanley), Katie Keranen taught the new field geophysics capstone course (three weeks) for the first time.

Top Left: Geophysics student Cullen Hogan, demonstrates the use of the "thumper," the source for the seismic studies. The geophysics students designed, acquired, processed and interpreted seismic data while at camp. The geologists also had acquired some geophysics data around camp.

Top Right: Students and Clyde M. Becker Jr. at the fire pit.

Bottom Left: The Kawasaki "mule" with Denny and Dixie – setting off for the high camp.

Bottom Right: Pam and Clyde Becker, Neil Suneson, Jeff Kelley, Gary Stewart and Doug Bellis.



Top Left: Students relax in their cabin.

Top Right: The plaque on the dining hall acknowledging the donors of the deck.

Bottom Left: The Bartell Field Camp.

Bottom Right: The geophysics class with the ATV.

Faculty/Student
Articles

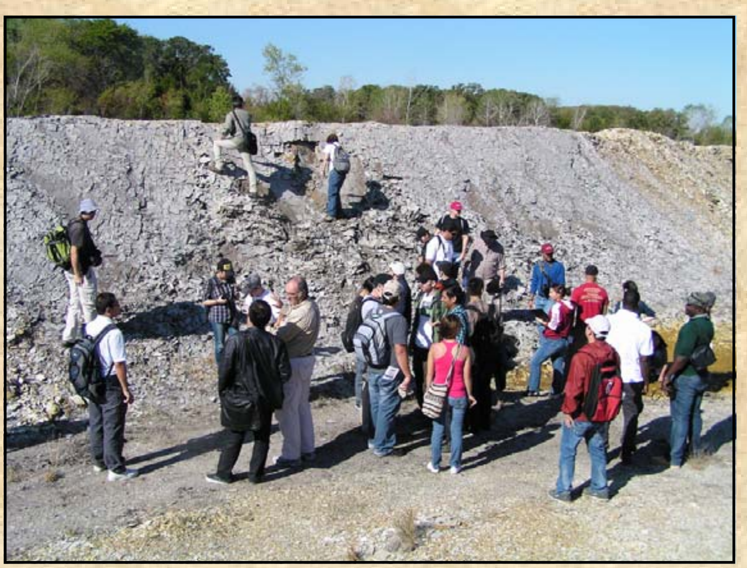
HALLIBURTON-SPONSORED TRIP TO WOODFORD SHALE

Neil H. Suneson
Oklahoma Geological Survey

The hottest resource-shale play in Oklahoma right now is the Woodford Shale, and some of the best exposures of the Woodford Shale are in and around the Arbuckle Mountains. Thanks to a sponsorship from the Halliburton Educational Foundation, nearly 40 graduate and undergraduate students from G&G and PGE got to spend a beautiful Saturday (OK …….. it was a bit warm for Oct. 15) in the field seeing this shale reservoir unit . Many of the students were from Professor Roger Slatt's GEOL 6970 Introduction to Reservoir Characterization class, and Dr. Slatt served as a superb co-leader of the trip. In addition, Brian Cardott from the Oklahoma Geological Survey attended and certainly deserves credit as a third leader. Brian has done a great deal of research on the Woodford Shale throughout his career with the Survey and has compiled the world's most extensive bibliography on the Woodford (available on the OGS website).

The day did not start out well. One of the vehicles had transmission "issues" just outside of Norman and managed to limp back to Sarkeys. Either the "issues" resolved themselves or remained below the radar for the remainder of the trip, but the van seemed OK and, after a couple of bail-outs, several determined students re-started the trip in a seemingly working van an hour late.

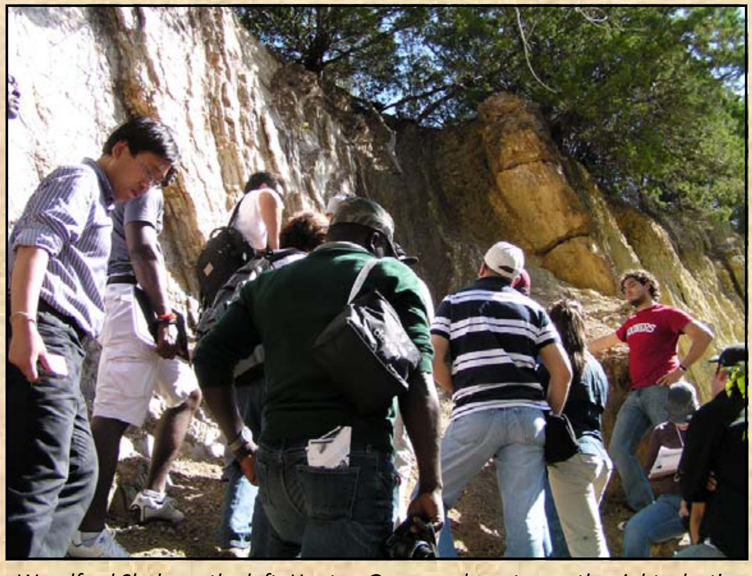
The first stop was the McAlister Cemetery shale pit in the Criner Hills south of Ardmore. We examined the poorly exposed basal contact of the Woodford with the Hunton Group and promised ourselves we'd see a better contact later. We then marched across the well-bulldozed, mostly siliceous shale, where some of us got to see the amber-like *Tasmanites* in hand specimen. At a cut through the formation, Brian had the group searching for tar balls, and just beyond there, Roger had us examine asphalt-filled fractures. The field evidence for the origin of the asphalt is contradictory – the old oil clearly could not have come very far, given that the only permissible pathways (bedding planes, major fractures) are not caked with asphalt. Did the old oil come from the immediately adjacent rock? Hard to imagine, given the virtually impermeable nature of the shale adjacent to the fractures. So exactly what is the origin of the asphalt in the Woodford fractures? TBD.



Geology and PGE students examine asphalt-filled fractures in the Woodford Shale. Photographs of this outcrop appear in nearly every guidebook that's been written about the Woodford, and many "collectable" specimens remain for the hydrocarbon enthusiast.

At the top of the Woodford section in the shale pit, the unit contains abundant phosphate nodules. Roger explained that if you were attempting to geosteer a horizontal well through the Woodford, knew phosphate nodules were near the top, and began to see them as you were drilling, you'd know enough to begin to steer down into the formation. This is why it is so important to know the facies variations through any formation you're developing, not just the Woodford.

Back up (north) Interstate 35 lay our next outcrop – Hwy 77D where it passes beneath the interstate. Here the Hunton/Woodford contact is beautifully exposed and it looks exactly what it should look like – an unconformity representing at least 26 million years (that's 2/5 of the entire Cenozoic!) of nondeposition. In detail, however, and in terms of sequence stratigraphy, one can see a transgressive-lag conglomerate that represents the arrival of the Woodford sea into this part of Oklahoma. An aspect of this unconformity that is as important as its origin is the effect it would have on hydraulic-fracture programs. If the Hunton contains water, it is not something you want to accidently frac into; therefore, it is critical to know something about the geomechanical properties of the unconformity or "transition" rocks between "good" Hunton and "good" Woodford. Is there enough soft rock to absorb any frac energy that might make its way down to the base of the Woodford? In addition, if you know that your gas-shale reservoir unconformably overlies a carbonate, what is the potential for karst to impact your fracs?



Woodford Shale on the left, Hunton Group carbonates on the right, clastic transition-zone rocks with a transgressive-lag conglomerate in the middle, students in the foreground. Knowing something about the lower (and upper) contacts of your reservoir unit is critical for its effective development.

Lunch. Finally. Almost 1:00 p.m. and everyone's starved. Again, thanks to Halliburton, we were not resigned to PB&J or even upscale ham and cheese sandwiches. Months ago OU alum Bob Allen from Ardmore turned me (NHS) on to Smokin' Joe's BBQ outside of Davis, so this is where we went. Brisket, pulled chicken, pulled pork, coleslaw, beans, fries (best beer-battered fries on the planet!), and drinks awaited us at picnic tables outside Joe's. No one went hungry or, if anyone did, it's their own fault. We now faced the serious problem of everyone wanting to take a nap after having eaten too much.

Yes ……. those are O's and U's that our students are making. This was the best we could do to show some school spirit, given that none of us would have the time to dash up to Lawrence to watch the Sooners flatten the Jayhawks 47 – 17 later that night. That's a big dipslope of Woodford Shale in the background.

We must thank Bob Allen for our last two stops on the trip, as these were part of an OCGS field trip that he led almost a year ago. The stops are located in the Arbuckle Wilderness wild animal park which, unfortunately, is not far from Joe's, so naps were not possible. Entering the park through the Events Center gate, we met our guide and headed off to the back part of the park where our only concern would seem to be two Alaskan musk ox grazing along the road.

Stop 3 of the day was an excellent exposure of the Mississippian Caney Shale, which at one time was also considered as a possible gas-shale target. There are some wells in the Caney but, given the currently low price for natural gas, this is a marginal play, at best. Regardless, this gave us the opportunity to contrast this shale with the Woodford as well as examine a couple of thin siltstone beds that might be storm deposits. Just down the road we could see the overlying Sycamore Limestone, and we knew that just around the bend lay the Woodford.

Stop 4 – a Woodford outcrop that not even Brian had seen in all his years of working on the Woodford. And an extremely unhappy outcrop of Woodford at that – clearly one with a very high B.I. (booger index) with lots of folds and faults. Part of the outcrop contained abundant phosphate nodules, suggesting it might be in the upper part of the Woodford, but the section here has yet to be measured and has yet to be studied by a student seriously interested in structural geology. Exactly how do the different lithologies behave (i.e., fracture or otherwise deform) on the limbs vs. crests of the folds? Do the faults provide pathways or seals in what normally is a very impermeable reservoir rock? What is the relationship between the folds and faults? How in the world would you drill something like this? Our stop at this outcrop was designed to show the students that many gaps remain in our knowledge of the Woodford Shale and that many good geologic projects (theses?) are still out there.

Relatively simple, well-stratified Woodford on the left, juxtaposed along a fault against very unhappy Woodford on the right. This would be an ideal outcrop to study exactly how the different rock types that make up the Woodford behave when folded and faulted.

Our last quickie stop of the day was to look at some more steeply dipping and overturned Hunton (where we again found the transgressive lag at the very top) and the Ordovician Sylvan Shale (lousy source rock, lousy reservoir, but nice frac barrier (as in the Arkoma Basin). Then out – through the ostriches and assortment of animals that you don't normally run into when doing field work in Oklahoma. And back to I-35 north and Norman.

Roger points to some bedding planes in the Woodford dipping moderately to the left. Just behind his "pointer" the beds in the Woodford are almost horizontal. Meanwhile, in background (upper left), the Woodford is again dipping to left. What goes on here? Could we be dealing with some structure?

A big thank you to Halliburton for sponsoring our look at the Woodford Shale. There's no question that seeing in the field what we drill in the subsurface is key to the successful development of these unconventional-resource plays.

HALLIBURTON

PIRE China

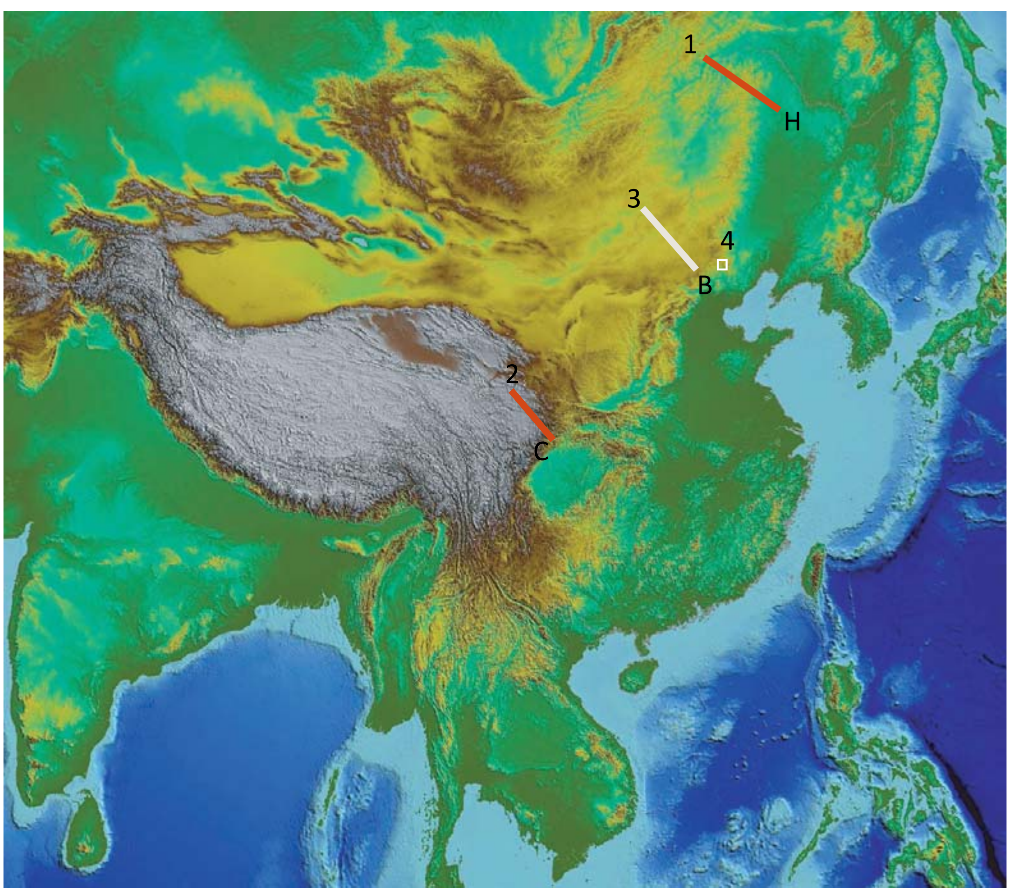
Randy Keller

Randy Keller continues to be involved in seismic experiments in China. His work is funded by a major National Science Foundation grant and focuses on better understanding intraplate earthquakes in China and the United States. Beginning in the summer of 2011, he sent research scientists Stephen Holloway and Michele Guo and two different groups of students to China to participate in the recording of two 400 km (250 mi) long seismic lines. These efforts are part of our ongoing collaboration with the Chinese Academy of Geological Sciences that leads the SinoProbe project. These experiments employed 500 seismic recorders from the NSF-funded IRIS/PASSCAL instrument pool and were designed by Randy and colleagues as part of a series of research grants.

These two seismic lines are at opposite ends of China. The first one was in the far northeast part of the country (Line 1, red on the map) and targeted the structurally complex Central Asian orogenic belt as we did in December of 2009 with Line 3 (white on the map). The second one (Line 2, red) is in the Sichuan Province and passes from the Sichuan basin, over the large fault that bounds this basin on the northwest, and onto the Tibetan Plateau. This fault was the one that slipped in 2008, killing at least 70,000 people. The steep terrain along most of this line was a challenge to man and machine.

The white square on the map indicates the 3-D experiment we did in 2010 in cooperation with the Chinese Earthquake Administration. This experiment targeted the Tangshan area, where an earthquake in 1976 killed at least 250,000 people. Our resident Hawaiian, Ph.D. student Jefferson Chang, has analyzed this data set, and his results have been communicated to our CEA colleagues, who are using them in their earthquake hazard analysis of the area.

During the past year, we have again hosted a series of Chinese students and researchers as part of this effort, providing all involved nice opportunities to interact and learn about each other's culture and form some enduring friendships.



Releasing and Restraining Bends in Strike Slip Faults

Shankar Mitra and Debapriya Paul

Bends or offsets in strike-slip faults result in the formation of extensional or contractional structures, which are typically oblique to the trends of the faults. Releasing bends result in the formation of pull-apart basins characterized by normal faulting, whereas restraining bends result in oblique contractional structures with associated reverse faults. Experimental modeling is used to study the geometry and evolution of structures and related secondary faults along releasing bends and offsets and restraining bends on strike-slip faults. The controls of the relative positions of adjacent strike-slip faults on the geometry of the structures, and the difference in geometries between bends and offsets are investigated. A new method of laser-scanning is used to map the geometry and evolution of the structures and related faults. The mapped geometries can be directly compared to natural subsurface structures.

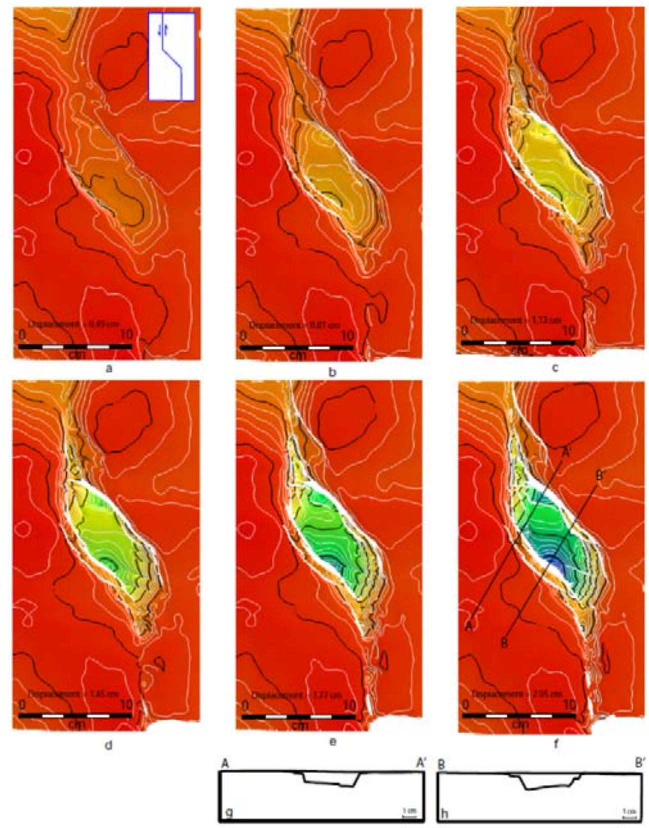


Figure 1

The models show that oblique releasing bends connecting approaching faults result in spindle shaped basins (Figure 1), whereas transverse bends result in more S-shaped, or rhombic, basins. Offsets result in the distribution of strain over a wider area and a larger number of faults, compared to pre-existing bends, which result in fewer well-defined basin-bounding faults (Figure 2). Secondary faults include R, R', and Y Riedel shears near the main strike-slip faults, and oblique normal faults in the center of the basin. Fault patterns exhibit en echelon geometries with a progressive step down into the deepest parts of the basin. Symmetric, asymmetric, and double basins may form in any of the structural settings, depending on the slip distributions among faults on the basin margins.

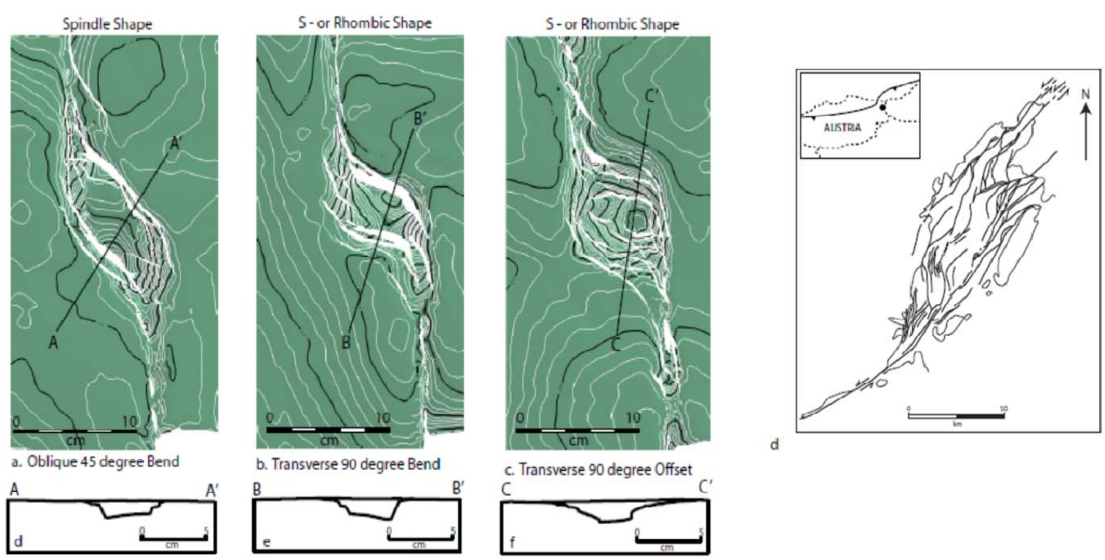


Figure 2

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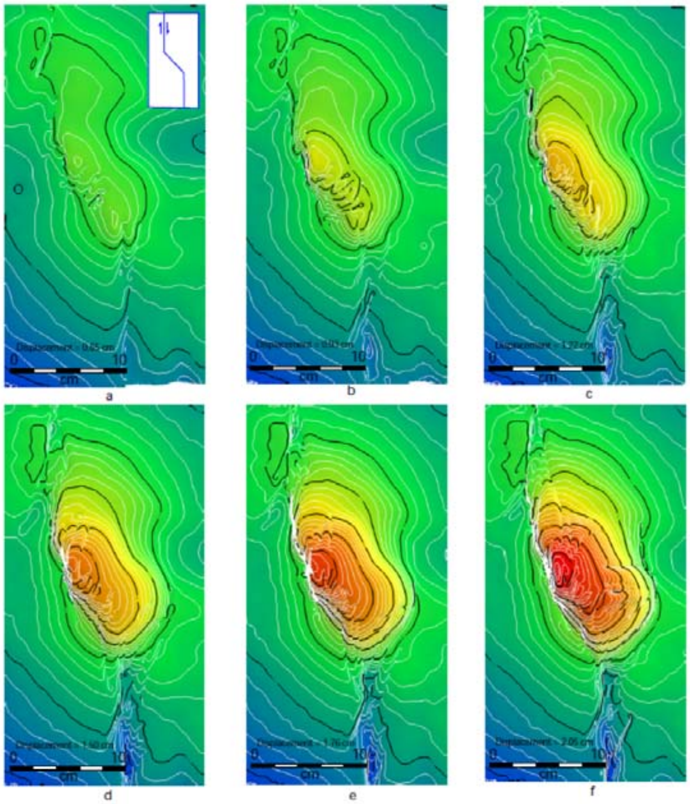


Figure 3

For restraining bends, oblique (45 degree) bends connecting approaching faults result in spindle-shaped uplifts (Figure 3), whereas transverse or oblique (135 degree) bends connecting overlapping faults result in more rhombic or rectangular uplifts (Figure 4). The fold trends are at increasingly higher angles with the strike faults for transverse and oblique (135 degree) bends. Secondary faults include en echelon reverse faults, which typically form along the steep limb of asymmetric uplifts, normal faults, which are transverse or oblique to the axis of the structure, and R, R' and Y Riedel shears near the main strike-slip faults. The aspect ratios of the basins and uplifts increase with increasing displacement on the strike-slip faults. The results of these models can be used to interpret the structural and fault geometries in surface and subsurface structures formed along strike-slip faults.

For more details, please see the following reference in the A.A.P.G. Bulletin:

Mitra, S., and Paul, D, 2011, Structural geometry and evolution of releasing and restraining bends: Insights from laser-scanned experimental models, A.A.P.G. Bulletin, v.95, p. 1147-1180. ■

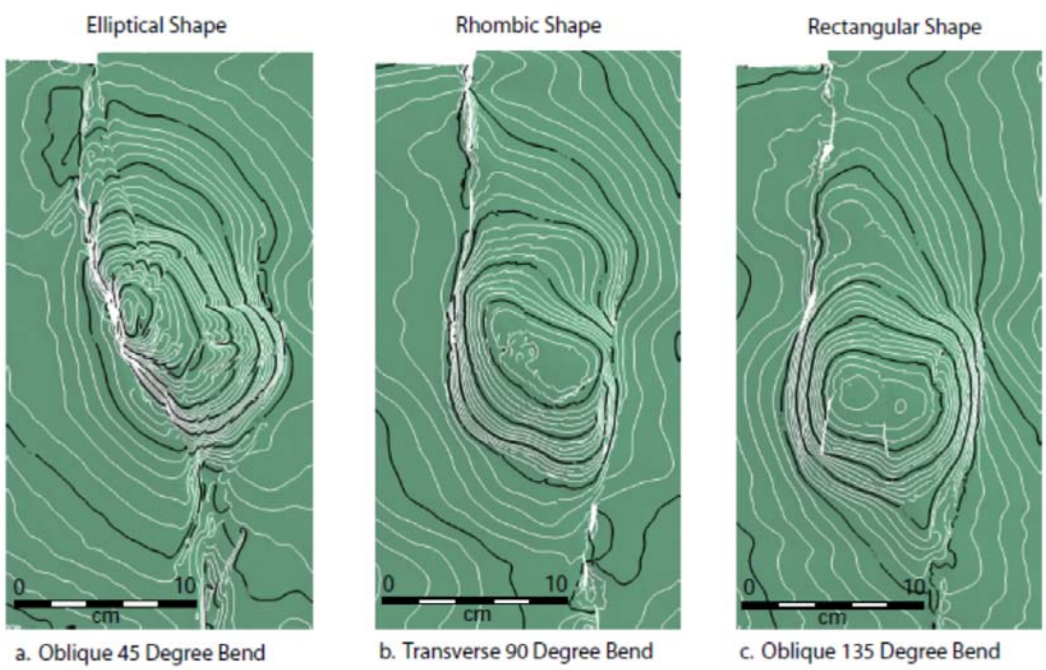


Figure 4

Activities of the Institute of Reservoir Characterization within the ConocoPhillips School of Geology and Geophysics: 2010-2011

Roger M. Slatt, Director

The heart of the institute is its graduate students, who number about 15 to 20 at any one time. This year, we had a record 13 M.S. and Ph.D. students graduate. Fifteen additional students currently are enrolled in graduate studies through the institute. Institute research is focused in three broad research areas: (a) unconventional resource shales/sandstones, (b) reservoir characterization, and (c) deepwater petroleum geology. For the past two years, the group benefited from the presence of Omar Abouelresh, Ph.D., who was a visiting research scientist at the institute, who recently returned to his native country to resume teaching at Suez Canal University of Egypt. We continue to benefit from collaborations with Younane Abousleiman, Ph.D. (OU-Poromechanics Institute), Paul Philp, Ph.D. (OU-School of Geology and Geophysics), Neal O'Brien, Ph.D. (SUNY-Potsdam), and Eric Eslinger, Ph.D. (The College of St. Rose, NY). A summary of activities of the students and associated faculty is presented below.

Unconventional resource shales/sandstones

The institute's program in resources shales and tight gas sandstones continues to grow. This year, a research program was initiated to evaluate and quantify pore types and pore networks in unconventional shales. There is considerable literature and excitement over the recognition in 2009 of nanoscale pores contained within organic matter in Paleozoic shales. However, as noted by Slatt and O'Brien (December 2010, AAPG Bulletin), there are other types of pores in shales that can be at least as important as organo-pores in the storage and transport of gas and oil molecules.

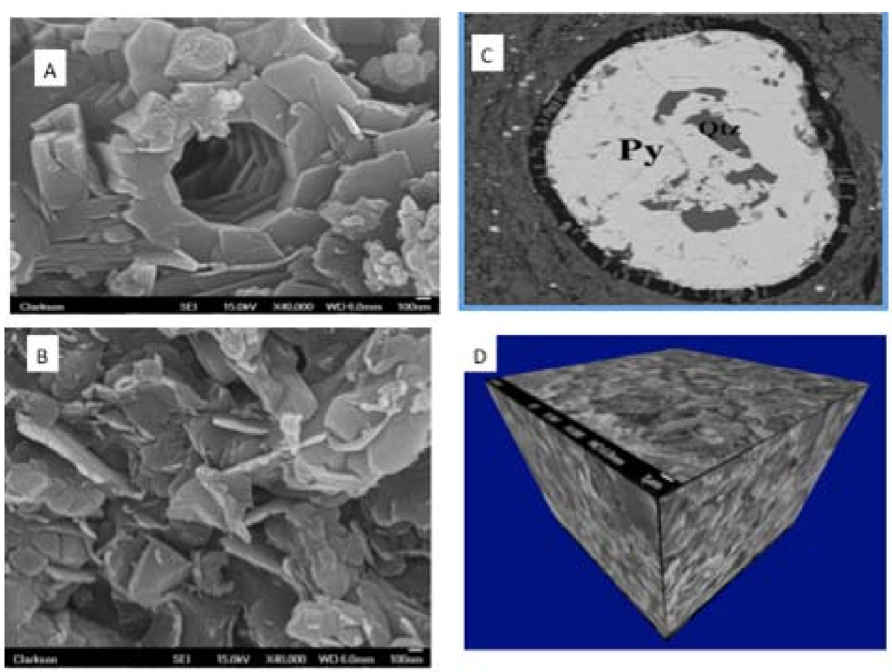


Figure 1: A. Coccolith plates with porosity, Eagle Ford Shale; B. Floccules with pores, Eagle Ford Shale; C. *Tasmanites* cyst with outer organic wall and inner fill of authigenic quartz and pyrite, Woodford Shale; D. 3D image of Scanning Electron Microscope scans of Eagle Ford Shale.

This research is currently funded through a consortium of oil and gas companies, that as of this writing, include Anadarko, Black Diamond, Chesapeake, ExxonMobil, Nexen, QEP, and Southwestern Energy. We have been, or are currently working, on a variety of important resource shales, including Barnett, Woodford, Eagle Ford, Fayetteville, Marcellus, Longmaxei, LaLuna, Horn River, and Haynesville.

Students who have within the past year completed M.S. theses in shale studies are ***Henry Badra*** (now with Noble Energy), ***Rafael Sierra*** (now with Noble Energy), ***Katie Hulsey*** (now with ConocoPhillips), ***Matt Totten*** (now at BP) and ***Majia Zeng*** (now with PetroChina). Students nearing completion of their theses as of this writing include ***Chris Althoff*** (Woodford), ***Brian Killian*** (Woodford), ***Carlos Ceron*** (Fayetteville), ***Andrea Magoon*** (Caney), and ***Lindsey Guest*** (Marmaton). New students, or returning (from summer internship) students, working on shales include ***Adam Chain*** (Woodford), ***Emilio Parada-Torres*** (LaLuna), ***Jean David Amorocho*** (Woodford), ***Andrea Serna*** (no thesis topic yet), ***Richard Brito*** (no thesis topic yet), ***Luis Castillo Morales*** (no thesis topic yet), and ***Ellen Stuchley*** (no thesis topic yet). One of our former M.S. students, ***Elizabeth Baruch***, has now gone to the University of Adelaide, Australia, to study shales for her Ph.D. dissertation.

One measure of the value of our shale research studies is the ease at which students obtain petroleum industry employment upon graduation. Another measure is the recognition of accomplishment through publication and presentation. ***Roger Slatt*** and ***Younane Abousleiman*** recently were honored by receiving the ***Jules Braunstein Award for Best Poster*** at the 2011 National AAPG Convention. Title of the winning poster is *Multi-scale brittle-ductile couplets in unconventional gas shales Merging sequence stratigraphy and geomechanics.* A similar paper was published by them in the April 2011 The Leading Edge. This research exemplifies the value of integration of disciplines to better advance knowledge and understanding of this complex type of reservoir.

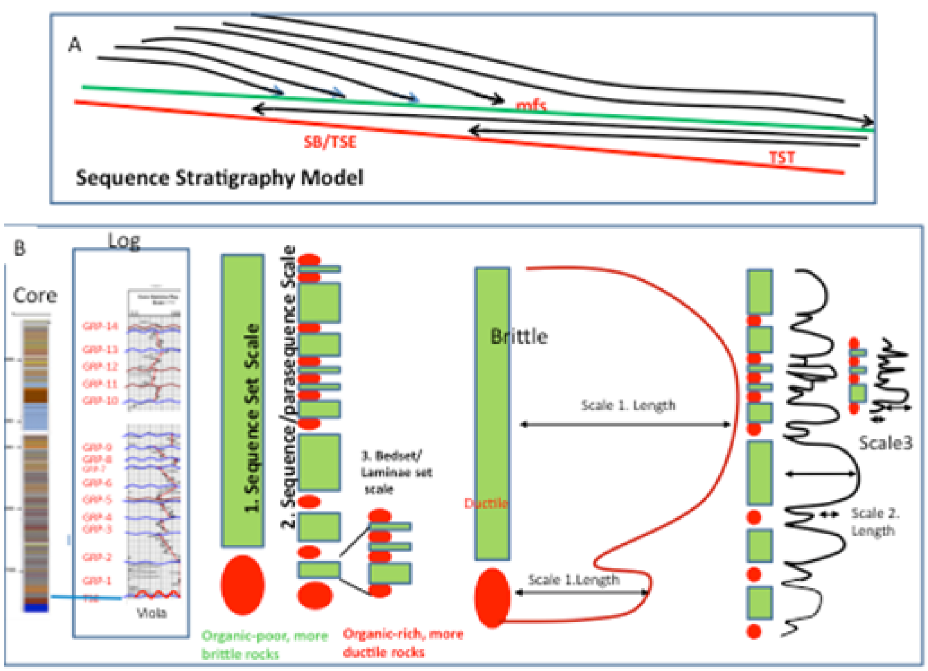


Figure 2. A. General sequence stratigraphic model for unconventional resource shales (Slatt and Rodriguez, 2011). B. Scales of brittle-ductile couplets in shales; three scales of couplets are shown: sequence scale, parasequence scale, and bed/bedset scale. Relative fracture lengths are postulated.

In the area of tight gas sands, ***Fuge Zou*** is pursuing his Ph.D. with a comparative study of the Pennsylvanian Jackfork Group tight gas sandstones in Oklahoma-Arkansas and the Triassic Songpan-Ganzi Complex in southwest China. Both of the basins containing these rocks are remnant ocean basins caused by continent-continent collision, and both hold petroleum potential. ***Ryan Davision*** (now with Chesapeake) completed his M.S. thesis on the origin of sand injectites in the Jackfork Group. ***Levi Pack*** completed his M.S. thesis on production characteristics of Jackfork sheet and channel sandstone reservoirs. ***Veronica Liceras*** (now with GeoQuest) completed her M.S. on 3D modeling and simulation of the Jackfork at Hollywood Quarry. Owing to considerable economic interest in tight gas sands in China, ***Duan Xinguo,*** *Ph.D.*, associate professor of geology at Chengdu University of Technology, has joined the group for a six-month sabbatical to study tight gas sandstones like the Jackfork.

Other (non-shale) research within the institute

Other research studies involve reservoir characterization of clastic rocks and petroleum geology of deepwater depositional systems. Recently, ***Sunday Amoyedo*** completed his Ph.D. degree on the affects of production on geomechanical properties of 'overburden' shale in the Forties Field, North Sea. ***Supratik Sarkar*** (now with Shell) completed his Ph.D. degree on geologic controls on production of the Chicontepec Field in Mexico. Also during this past year, ***Aslihan Deliktas*** (now with TPAO, Turkey) completed a seismic sequence stratigraphic study of the More Basin in the Norwegian Sector of the North Sea. Both ***Fuge Zou's*** and **Jonathan Funk's** (both now with Marathon) theses have been accepted for publication. ***Andrea Cadena*** is nearing completion of her M.S. thesis on tectono-stratigraphy of the offshore Magdellana Fan, Caribbean offshore, Colombia. New graduate student ***Carlos Molinares*** also will be studying deepwater potential in offshore Colombia.

Other activities of the institute

Both Introduction and Advanced Reservoir Characterization courses are taught by ***Professor Slatt*** and ***Professor Abousleiman*** to OU geoscience and petroleum engineering students. The advanced course deals mainly with geological reservoir model-building using Schlumberger's Petrel™ software; ***Eva Peza***, of Schlumberger kindly offers her free time each year to teach the basics of Petrel™ to the class.

Short courses by ***Professor Slatt*** on Clastic Reservoir Characterization and Sequence Stratigraphy continue to be popular among international oil companies and geosciences organizations. South America is the current focus area for these courses, thanks to the tireless efforts of ***Yoana Walschap***, director of the Energy Institute of the Americas, who organizes such courses as well as recruits excellent South American graduate students. This past year has seen a growing demand for ***Slatt's*** new ***Geology of Unconventional Resource Shales***; it has now been taught in Argentina, Colombia and Indonesia, as well as in some U.S. locales. This course currently is being integrated into the Introductory Reservoir Characterization course at OU. ***Slatt*** has teamed up with ***Yucel Akkutlu, Ph.D.*** (OU School of Petroleum and Geological Engineering), to teach both the geology and engineering aspects of shales and with ***Professor Paul Philp*** (OU ConocoPhillips School of Geology and Geophyscis) to teach both the geology and geochemical aspects of shales. Next year, ***Slatt*** and ***Akkutlu*** will be teaching a field-lecture course on shales for Nautilus™, a well-known international training organization. ***Slatt*** currently teaches through other such organizations, including the Subsurface Consultants Association, Petrogroup (S.A.) and Indonesian Petroleum Association.

In summary, we anticipate another exciting year fulfilling our charter to educate students in applied reservoir, as well as exploration geology, and to advance the science of reservoir characterization.

Cluster assisted 3D unsupervised seismic facies analysis, an example from Osage County, Oklahoma.

Atish Roy and Kurt J. Marfurt

Introduction

The most popular seismic attributes fall into three broad categories – those that are sensitive to lateral changes in waveform and structure such as coherence and curvature, those sensitive to thin bed tuning and stratigraphy, such as spectral components, and those sensitive to lithology and fluid properties – such as AVO and impedance inversion. We present a workflow that mimics multiattribute clustering routinely done by human interpreters that can differentiate depositional packages characterized by subtle changes in the stratigraphic column as well as lateral changes in texture.

Our work is built upon that done by many others who have worked on volumetric seismic facies mapping. The algorithm is based on Kohonen self-organizing maps (SOM), which is one of the commonly used unsupervised classification algorithms.

Kohonen Self Organizing Map

Kohonen (1982) presented his clustering and dimensionality reduction methods as a “self-organizing process” whereby a “simple network of adaptive physical elements” is made to resonate in a particular way with externally provided signals (a “primary event space”) and tried to link these ideas with the functionality of the human brain (Murtagh, 1995). This popular neural network method was initially used in biology and computer science for data mining purposes, and has been since used in speech recognition and automated pattern-recognition in seismic exploration. SOM (Kohonen, 2001) clusters data such that the statistical relationship between multidimensional data is converted into a much lower dimensional latent space that preserves the geometrical relationship among the data points.

Application of SOM to generate 3D seismic facies volume

In the 3D SOM algorithm, the input consists of several mathematically independent volumetric attributes where the number of input attributes determines the mathematical dimensionality of the data. In this application, we normalize our input data vectors using a Z-score algorithm. Thus our input data has a vector assigned to each of the *(x, y, z)* location in our volume (which are actually the normalized input attribute values at that location). We call this new volume the normalized multi-attribute volume and project it onto a 2D latent space by Principal Component Analysis. These projected vectors in the 2D latent space are termed as the prototype vectors. We apply the SOM training rule to cluster these vectors. If there are five input attribute volumes, each of the PVs in the 2D latent space is 5-dimensional. This 2D latent space is sampled uniformly by 256 PVs. Due to the limitation of our visualization software which provides only 256 colors, we have limited our over-defined prototype vectors to a maximum of 256. The PVs are trained in the 2D latent space and their positions updated after each iteration, resulting in the new updated position of the PVs. When the updating slows down, the training process stops. With an increasing number of iterations, the PVs move closer to each other and to the data points within the latent space. The 2D HSV colors are assigned to the PVs according to their distance from their center of mass and their azimuth. Once trained, the distance is computed between each PV, $\mathbf{m}_i'$, and the multiattribute data vector, $\mathbf{x}$, at each voxel using

$$\|\mathbf{x}-\mathbf{m}_b'\| = \min\{\|\mathbf{x}-\mathbf{m}_i'\|\} \quad \text{.. (1)}$$

where $\mathbf{m}_b'$ is the nearest PV to the input data sample vector $\mathbf{x}$. Each voxel is then assigned the color of $\mathbf{m}_b'$. In this manner, two dissimilar neighboring samples in the seismic volume will be far apart in the latent space and have different colors (Roy et al, 2011).

Conversely, two similar samples in the seismic volume will have nearly the same color. Each color represents a seismic facies, most of which are geologic facies, but some which may be seismic 'noise' facies.

Application of SOM on a 3D seismic dataset from the Osage County, Oklahoma

We have used this 3D multiattribute clustering technique to understand the Mississippian tripolitic chert reservoirs (Thorman and Hibpshman, 1979) and the formations below Oswego limestone. The Mississippian tripolitic chert reservoir, informally called "Mississippian Chat" by drillers, is formed from exposed and diagenetically altered cherty limestone (Rogers, 2001). Such complexities are expressed in their heterogeneity and are caused by faulting, fracturing and carbonate dissolution. Figure 1 shows the general stratigraphy of the Osage County.

We have two different analysis of input volumetric attributes to our clustering algorithm. The first analysis consisted of five attribute volumes namely peak frequency magnitude, Sobel filter similarity, coherent energy and two GLCM texture attributes variance and entropy. These attributes help in identifying the facies distribution within the survey. Figures 2-5 shows different features in the 3D seismic facies volumes generated as its output.
The second analysis consists of four input attribute volumes namely reflector convergence magnitude, coherency coherent energy and dip magnitude. These volumes when clustered help to identify the different lithological settings within the survey. Figures 6-8 shows different features in the 3D seismic facies volumes generated as output after the second analysis.

Discussion

The colored seismic facies volume from the multi-attribute analysis represents the variation in seismic facies. Different depositional facies are represented by a different waveform and are colored accordingly. Figure 2 shows each of the three sub-volumes (above Oswego formation, channel facies and Mississippian Lime) represented by three separate average waveforms having three different color patterns. Different depositional packages are represented by different colors as is evident from Figure 3 where the seismic amplitude is overlaid on the seismic facies classified section. Figure 4 shows a volume-probe (geobodies) below the Oswego formation where lies a shale-filled channel which is in greenish blue color but not very prominent and interpretation can be done only after overlaying the coherency cube over it. In Figure 5 the dark red colors are found mostly around the small anticlines which are interpreted as possible chert-rich zones. There is a need for more well control to study the areas in green in the southern part of the survey.

The second analysis does a better job in differentiating both the structural boundaries and the different seismic facies. Figure 6 is a volume-probe of the same formation below the Oswego formation. Here the channel facies are in light blue color and the outlines of the channel are also defined by deep blue color. The deep blue structural feature (highlighted by yellow arrow) in the southeastern part highlights a small dip along the section which can be confirmed when we analyze another crossline along the survey (Figure 7). The volume-probe (geobodies) within the Mississippian lime formation (Figure 8) from this second analysis helps better identify the heterogeneity of this zone. The blue color seismic facies are the higher dips that segments the possible chert-rich zones in the eastern half of the survey.

Conclusions

Here we have discussed an alternative workflow that provided a volumetric estimation of seismic facies. The heterogeneous nature of the chert reservoir is highlighted with the subtle color variation of the zone between the Mississippian Lime and the Arbuckle top. However, the power of classification is heavily dependent on the choice of attributes (Barnes and Laughlin 2002). Thus, compared to our first multiattribute analysis, the second analysis shows the structural and facies boundaries better within the seismic facies volume. However these applications are unsupervised. In this workflow, the results should be validated against well logs and conventional seismic stratigraphic interpretation.

Suggested Readings

Barnes, A. E., and K. J. Laughlin, 2002, Investigation of methods for unsupervised classification of seismic data: 73rd Annual International Meeting Society of Exploration Geophysicists, Expanded Abstracts, p. 2221-2224.

Elebiju, O. Olubunmi , Matson, Shane, Keller, G. Randy, and Marfurt, J. K., 2011, Integrated geophysical studies of the basement structures, the Mississippi chert, and the Arbuckle Group of Osage County region, Oklahoma, AAPG Bulletin; March 2011; v.95; p.371-393.

Kohonen, T. ,1982 Self-organized formation of topologically correct feature maps: Biological Cybernetics, v. 43 p. 59-69.Kohonen,T., 2001, Self-organizing Maps, 3rd ed.: Springer-Verlag.

Matos, M. C., K. J. Marfurt., and P. R. S. Johann, 2009, Seismic color Self-Organizing Maps: 11th International Congress of the Brazilian Geophysical Society, Expanded Abstracts.

Roy, Atish., and Marfurt, J. K., 2011, Application of 3D clustering analysis for deep marine seismic facies classification – an example from deep water northern Gulf of Mexico: GCSSEPM 2011.

Figures

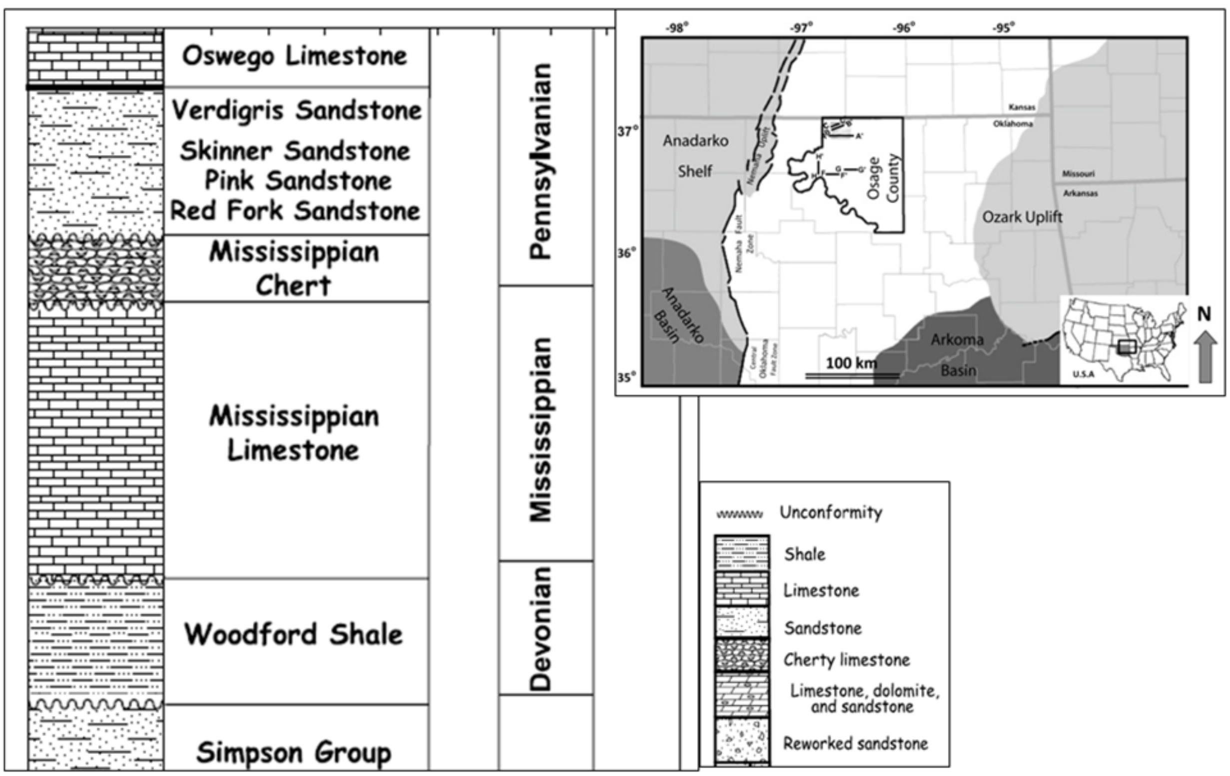


Figure 1: (a) Generalized stratigraphic column for Osage County (Elebiju et al., 2011). The Mississippian Limestone is charged by the underlying Woodford Shale. (b) Map shows the geological setting of the Osage County and the survey location.

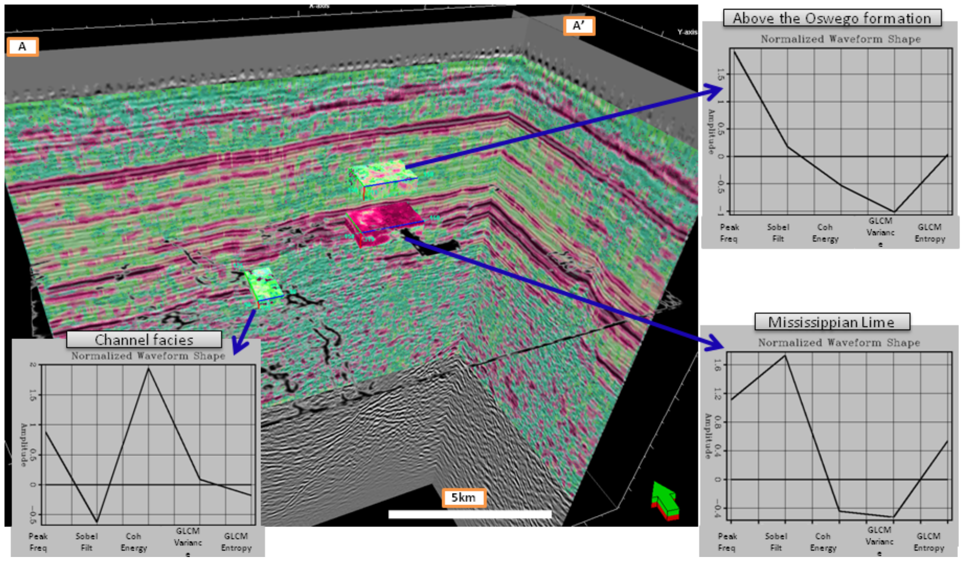


Figure 2: Each of the three sub-volumes from the first multi-attribute analysis (above Oswego formation, channel facies and Mississippian Lime) is represented by a waveform or pattern, of z-score scaled attributes obtained with principal component analysis. The arbitrary seismic section is a co-rendering of the facies classification volume with the seismic amplitude. Each individual waveform is the sum of the first 5 eigenvectors of that volume. The x-axis is the dimension of each sample (no. of input attribute volumes used). The input attributes in the proper order are also listed in the figure. Note how the waveform differs for different formations.

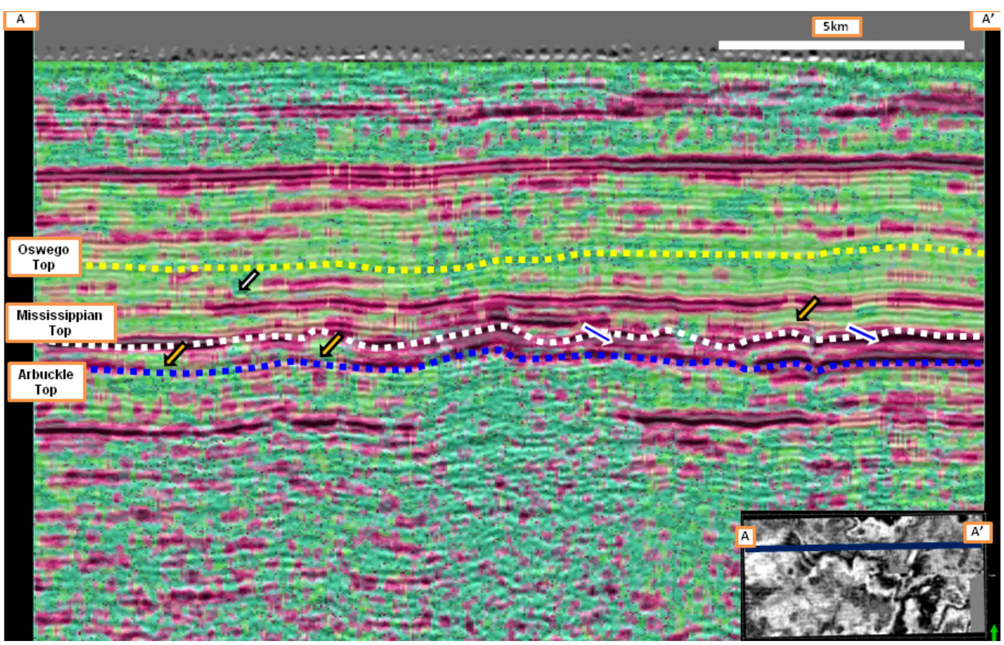


Figure 3: The co-rendered arbitrary vertical section AA' generated from the first multi-attribute clustering analysis with the seismic amplitude. This analysis consisted of five input attribute volumes, namely peak frequency magnitude, Sobel filter similarity, coherent energy and two GLCM texture attributes variance and entropy. Different arrows indicate different deposits. The white arrow below the Oswego top represents the shale-filled channel discussed below. The blue arrows represent possible chert deposits. Note all the figures of seismic sections and volume probes are vertically exaggerated 30 times.

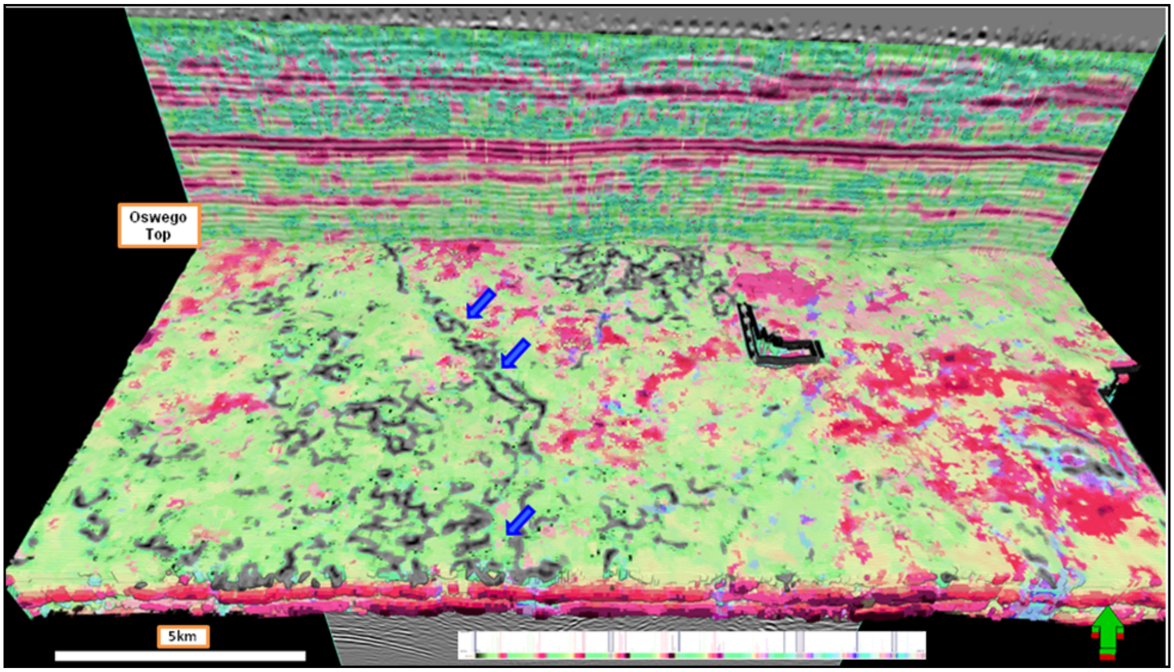


Figure 4: Seismic facies volume probe below the Oswego Limestone formation generated from the first multiattribute cluster analysis. The channel is better delineated co-rendering the coherency cube within the probe.

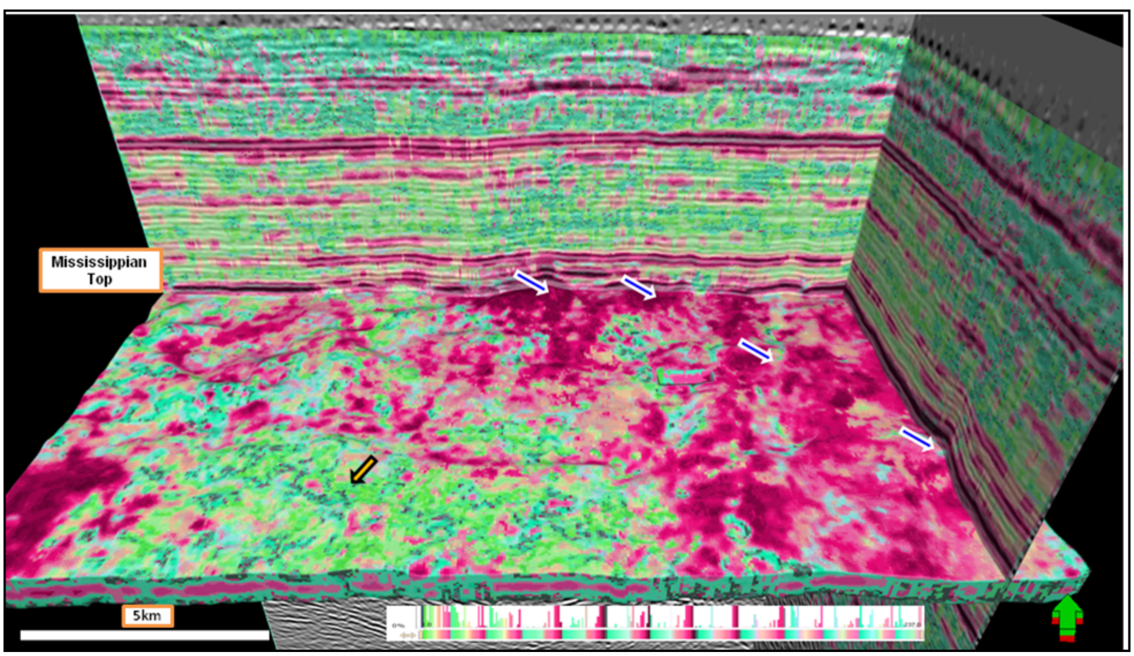


Figure 5: Seismic facies volume probe within the Mississippian lime formation generated from the first multiattribute cluster analysis. The dark red zones mostly around the small anticlines are the possible chert rich zones (highlighted in blue arrows). The green facies in the southern part of the survey has to be analyzed from the well data.

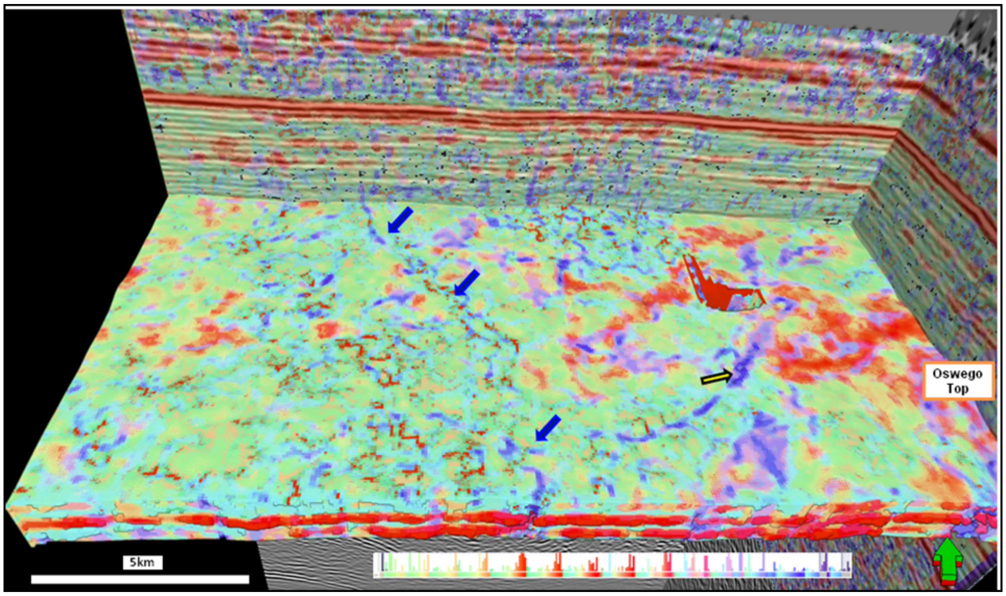


Figure 6: Seismic facies volume probe below the Oswego formation generated from the second multi-attribute cluster analysis. This analysis consists of four input attribute volumes, namely reflector convergence magnitude, coherency coherent energy and dip magnitude. Here the channel facies are highlighted in light blue and the channel boundaries are marked with dark blue facies color (highlighted in blue arrows). Thus the channel facies is better demarcated compared to the previous analysis. The dark blue lineament feature (highlighted in yellow arrow) in the south-west is studied in the next figure.

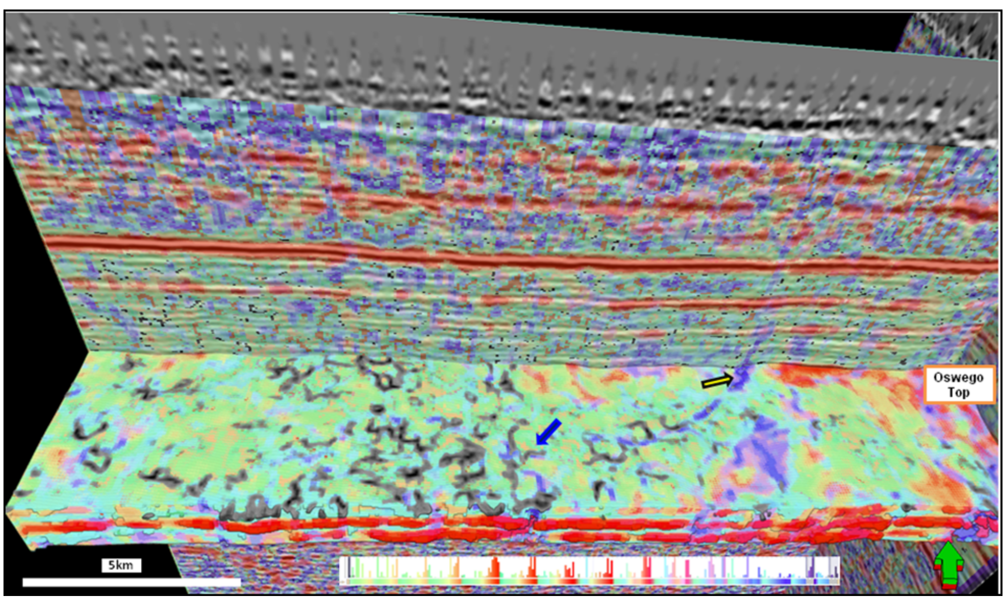


Figure 7: Seismic facies volume probe generated below the Oswego formation from the second multi-attribute cluster analysis. The co-rendered crossline over the blue lineament (highlighted in blue arrow) helps in interpreting the low magnitude dipping bed.

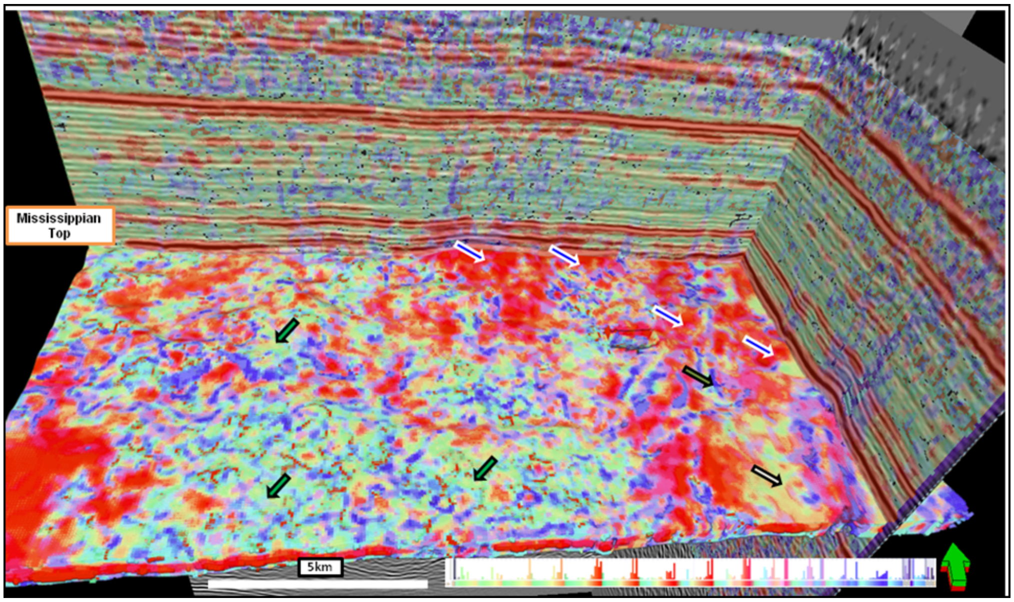


Figure 8: Seismic facies volume probe within the Mississippian lime formation generated from the second multiattribute cluster analysis. The heterogeneity in the Mississippian Lime is better observed from this analysis. The blue colored facies in the eastern part of the survey helps in segmenting the red facies better and these are interpreted as the possible chert rich zones. ■

Integrated Paleomagnetic and Diagenetic Studies at OU

Students working under the supervision of Doug Elmore, Ph.D., have recently completed or are currently working on several integrated diagenetic and paleomagnetic studies. Recently completed diagenetic studies of shale gas and associated units include the Barnett Shale and Ellenburger Formation in the Fort Worth Basin (Devin Dennie, Ph.D., 2010, and John Deng, M.S., 2011) and the Marcellus Shale (Earl Manning, M.S., 2011). The Ellenburger and Barnett have complex diagenetic histories (Fig. 1), particularly in and around veins (Fig. 2). Paleomagnetic data from around some veins suggests fluid alteration in the late Permian/early Triassic (Fig. 3). The Marcellus also has a complex diagenetic history (Fig. 4).

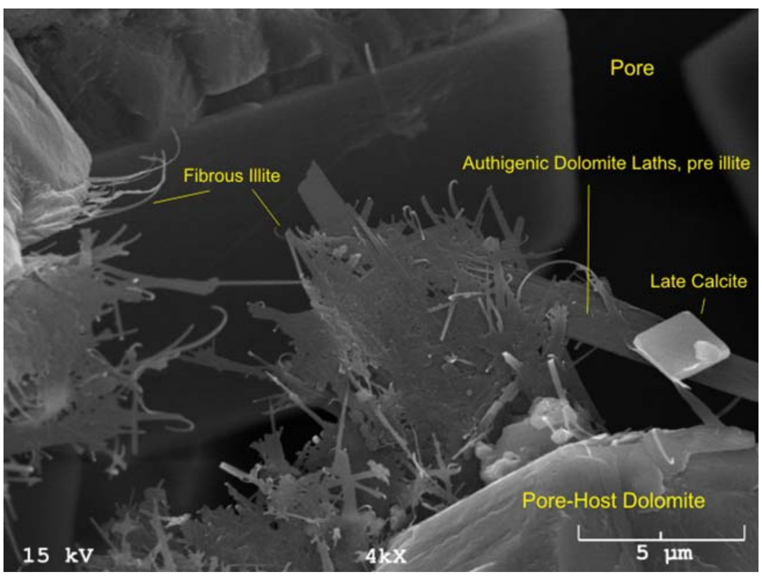


Fig. 1. SEM image showing cements growing in an open Ellenburger pore. Authigenic illite and late crystalline Fe-calcite is shown on dolomite.

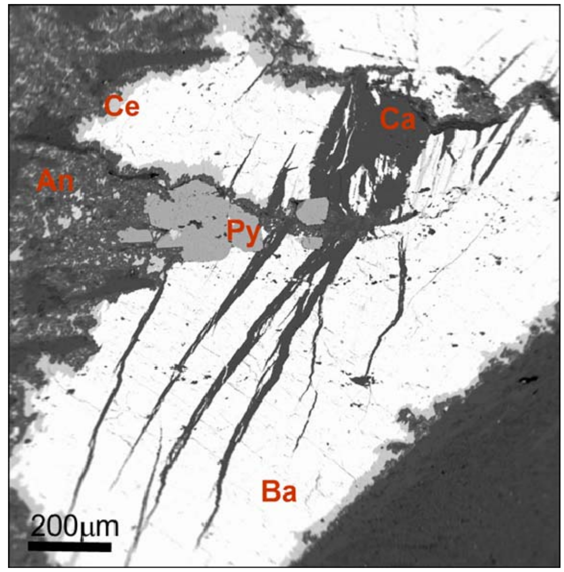


Fig. 2. Refractured fracture in the Barnett Shale from the Fort Worth Basin. Celestine (Ce, outer rim) and barite (Ba) make up the bulk of the vein. Late anhydrite (An) and pyrite (Py) crosscut the vein. A late calcite (Ca) cement "refractures" the barite, celestine and anhydrite along cleavage planes and between the barite and the matrix. (SEM, backscattered image).

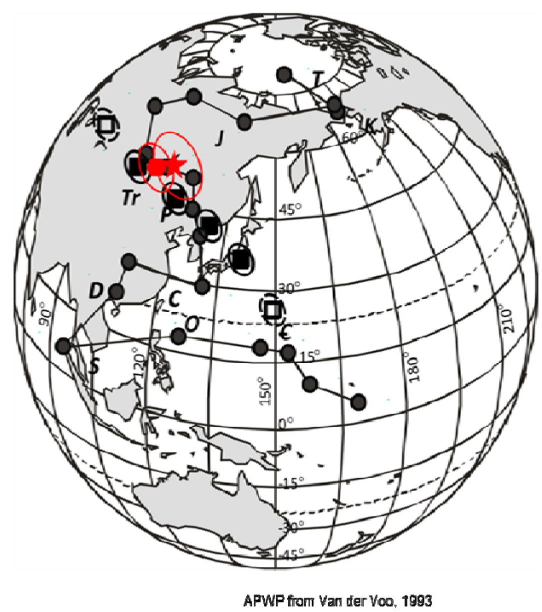


Fig. 3. Paleomagnetic pole positions for the magnetizations around the NE (star) and NW (octagon) veins on the apparent polar wander path. The results suggest that fluids that moved along NW and NE vertical fractures and altered the Barnett Shale in the Late Permian and Early Triassic.

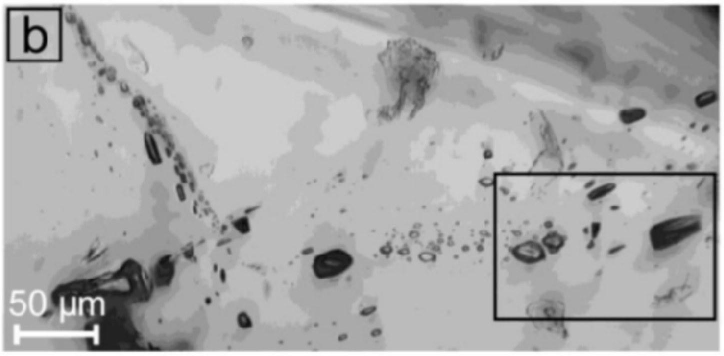


Fig. 4. Fluid inclusion from the Marcellus Shale in Pennsylvania. Two different inclusion trails are evident.

A current study, funded by Devon Energy, is focused on studying the Mississippian limestones in northern Oklahoma. Four students are working on the Mississippian limestones project: Sarah Farzaneh, Simon Anzaldua, Justin Haynes, and Bryant Bradley. The Haynesville Shale is the focus of the other study, which is being worked on by Alex Benton.

Mississippian limestones are a major target for hydrocarbon exploration in northern Oklahoma. The heterogeneity and compartmentalization of the unit are partially related to depositional control but diagenetic alteration can also have an effect on the reservoir properties. It can also influence the mechanical stratigraphy. Studies of diagenesis are commonly hindered by a lack of temporal control. In most diagenetic studies, only the relative timing of events is known. Determining the origin and timing of diagenetic events is important in studies of basin evolution as well as for the development of hydrocarbon exploration strategies. For example, it is important to know the timing of burial diagenetic processes such as maturation of organic matter and the smectite-to-illite transformation because they alter the rocks and can result in the generation or expulsion of fluids. Rock-fluid interactions caused by the expelled fluids or from externally derived fluids can play a major role in diagenesis.

We are integrating paleomagnetic, geochemical and petrographic studies to constrain the timing and origin of diagenetic events. The study of Mississippian limestones will use five cores (Fig. 5) as well as outcrops (in Missouri). Geochemical analysis will be utilized if the origin of magnetization is found to be chemically derived. Sr isotopes will be evaluated to determine if externally derived fluids altered the rock. Core descriptions, petrographic analysis, SEM analysis, and geochemical analysis will each contribute to the paragenetic sequence. Paleomagnetic techniques will help provide absolute timing of diagenetic events. Preliminary paleomagnetic analysis indicates the presence of a chemical remanent magnetization that can be used to date diagenetic events.

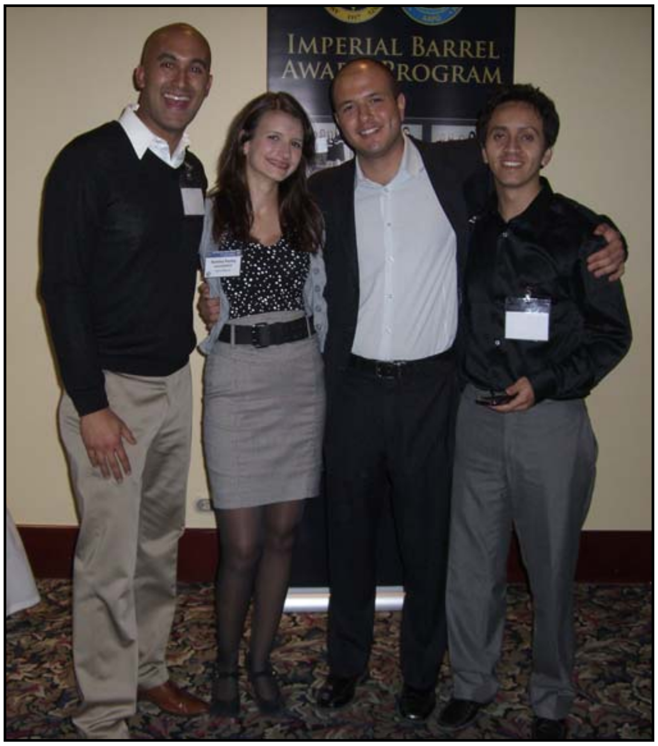
■

Fig. 5. Picture of a core from the Mississippian limestone.

Second Imperial Barrel Award Latin America Regional Competition

Romina M. Portas[1], Carlos Santacruz[2], Roderick Pérez[3] and Byron Solarte[4]

1.ConocoPhillips, Houston, TX, USA; 2.Noble Energy Inc, Houston, TX, USA; 3.ConocoPhillips School of Geology and Geophysics, University of Oklahoma, Norman, OK, USA; 4.Pathfinder Exploration, Norman, OK, USA



IBA Latin America Region Coordinators
From left: Roderick Pérez, Romina Portas, Carlos Santacruz and Byron Solarte.

By ROMINA PORTAS
IBA LA Sub-Regional Coordinator

The second annual Imperial Barrel Award Latin American Regional program took place March 11 in Bogota, Colombia. The competition, part of the AAPG's regions and sections activities, gathered students from Patagonia to Rio Grande in the coffee capital.

The IBA program was initiated to encourage teams of students to participate in a hydrocarbon exploration evaluation project to gain a similar experience to working in a petroleum company. Participating teams are provided with a data set that includes seismic and well logs. Within a strict time limit of six weeks, the teams are required to analyze the data, develop a portfolio of exploration drilling prospects and present their results to an independent panel of industry experts to be judged.

The Barrel Award has been a part of the petroleum geoscience master's program at Imperial College of London for the past 30 years. In 2007, AAPG made it a global program that has grown rapidly from seven to 88 participating universities worldwide, divided into 12 regions.

The Latin American region, which includes universities from Central and South America, started in 2010. Thanks to the efforts of Carlos Santacruz, a University of Oklahoma alumnus who participated in the program, together with former Barrel Award participants and OU alumnus Roderick Perez, Romina Portas and Byron Solarte. The IBA program creates leaders as well.

"In a globalizing world, we couldn't understand how Latin American universities were not involved in this activity. Besides academic gain, the program breaks language, regional and industry barriers. It provides networking for the students and faculty. It even helped us (the coordinators) develop our leadership skills," said the region coordinators.

The IBA LA is the newest and most active region, growing from one participant in 2010 to seven universities representing Argentina, Brazil, Colombia, Mexico and Venezuela. The competition was all day Friday; each team had 25 minutes to do its presentation, followed by 10 minutes of discussion. The award ceremony was on the evening of that same day, where the event coordinators announced the winning teams. Third place went to the Universidad Nacional de La Plata, Argentina; second place went to Universidad Central de Venezuela; and first place went to Universidad Nacional de Colombia (UNAL).

The UNAL team, composed of Freddy García, Ignacio Iregui, Felipe Medellín, Daniel Pineda and Thais de Sousa, with Enrique Velásquez as a faculty adviser, is one of the 12 teams advancing to the global final competition that will take place the Friday preceding AAPG's Annual Convention and Exhibition in Houston. Let us wish them success and hopefully they will come back home with the highest recognition.

Hopefully next year, universities from surrounding countries will decide to participate, making the annual event a bigger and more diverse one.

The IBA LA regional event could not have been possible without the support of 11 generous sponsors. Muchas gracias, Obrigado!

(Contact Carlos Santacruz, AAPG's IBA LA Reginal Coordinator, at 1-281-874-6094 or email to csantacruz@nobleenergyinc.com.)

Mappin g Unaweep Canyon, and Assessing the Environment of the Permian Cutler Formation

(Summers 2010-2011) By Lynn Soreghan

Tad Eccles (B.S. 2010; M.S. in progress) assisted by Austin Shock (B.S. 2010) in summer 2010 and Dan Ambuehl (B.S. 2011) in summer 2011, joined the long list of distinguished OU students to work in Unaweep Canyon of western Colorado. Unaweep Canyon, a large U-shaped gorge on the Uncompahgre Plateau, is said to be the only canyon in the world with two mouths. Our work for the summers of both 2010 and 2011 was funded by the USGS EDMAP program and entailed mapping key elements of the canyon to test the hypothesis of a Paleozoic, and possible glacial, origin for this remarkable and enigmatic landscape. As newly minted field-camp veterans in 2010, Tad and Austin brought their freshly honed mapping skills to the project, and Dan assisted Tad after Dan's field camp stint in 2011. During both summers, the students spent several days learning the geology of the region with me. The EDMAP program places particular emphasis on student mentoring and on partnering with local surveys; hence we also spent days with geologists from the Colorado Geological Survey (Vince Matthews, Ph.D., and Dave, Ph.D.), and were also joined by Neil Suneson, Ph.D., of the OGS, in both 2010 and 2011. This work forms part of Tad's M.S. thesis work, and will result in some of the first detailed (1:24,000 scale) maps of this region, which is now covered only by a 1960s-vintage 1:250,000 map compiled in part from photos dating from the 1940s.

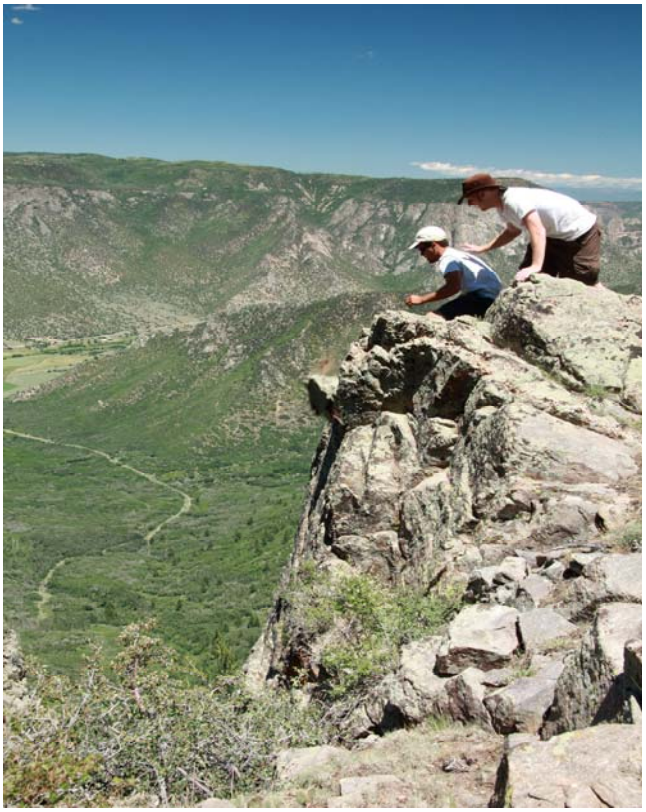
Additionally, Leslie Keiser (Ph.D. in progress) is working on the Permo-Pennsylvanian Cutler Formation at the western mouth of Unaweep Canyon. Leslie is studying quartz microtextures using the Scanning Electron Microscope to help infer modes of physical erosion and test the possibility of a proglacial origin for the Cutler Formation, which has traditionally been interpreted to record warm tropical conditions.

Previous OU students who have worked in this area include Sara Kaplan (M.S. '07), Kate Moore (M.S. '07), Kristen Marra (B.S. '05, M.S. '07), Dustin Sweet (Ph.D. '09), Oswaldo Davogustto (B.S. thesis '07), and Yoscel Suarez (M.S. '07). To date, publications on this work have appeared in *Geology*, *Journal of Geology*, Journal *of Sedimentary Research*, and *The Mountain Geologist*, with the latter paper (senior authored by Kate Moore) garnering the best paper award for 2008.

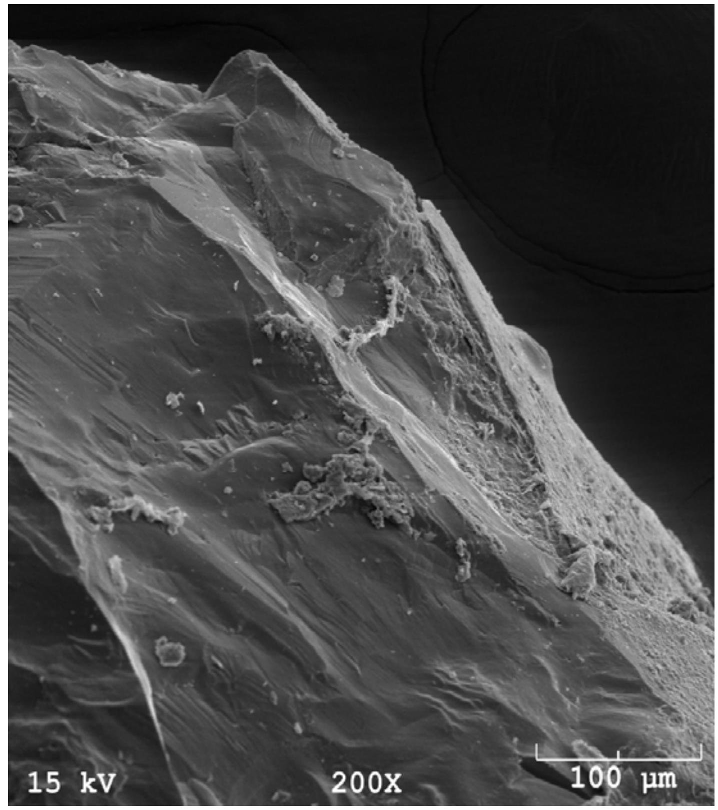
Tad and Austin view the Mesozoic stratigraphy of Colorado National Monument with Colorado State Geologist Vince Matthews, Ph.D.

Contemplating the nonconformity surface with Dave Noe, Ph.D., of the Colorado Geological Survey.

Are Tad and Austin smiling because they've found the fault?



We hiked to the Precambrian canyon rim to sample for thermochronology, a means to understand the uplift history of the Uncompahgre Plateau. Here, Austin is kindly helping Tad get a head start on the hike back down to the road.



SEM photomicrograph of a quartz grain from the Permo-Pennsylvanian Cutler Formation, showing a deep trough with precipitation atop. Leslie Keiser is studying the occurrence of features such as these, which are thought to record high-stress processes including glacial grinding.

Tad and Leslie stand atop the Precambrian basement (1.4 Ga), examining the onlap of the Permo-Pennsylvanian Cutler Formation, and sampling in the proximal-most Cutler to examine SEM textures.

On the Origin of Oklahoma's Red Dirt

By MikeSoreghan, Ph.D., and Lynn Soreghan, Ph.D.

Members of our collaborative research group on Permian redbeds visit Oklahoma's Glass Mountains from left: Tyler Foster, M.S. student; Mike Soreghan, Ph.D.; Kathy Benison, Ph.D. (CMU); Molly Kane, M.S. student; Lynn Soreghan, Ph.D.; and Jay Zambito, Ph.D. (post-doc, CMU).

Halite molds from the Nippewalla (Flower Pot -equivalent) of southern Kansas.

We are collaborating with Kathy Benison, Ph.D. (Central Michigan University), on a project to study the classic Permian redbeds of the Midcontinent. Whereas Professor Benison's focus is the chemical strata such as gypsum and halite that are commonly associated with these redbeds, our focus is the origin of the clastics themselves, including the provenance, which we plan to study using whole-rock geochemistry and detrital zircon geochronology. We are testing new ideas about the origin of the redbeds and extraction of a detailed climate signal from these strata. This project is just beginning, so look for more reports in future issues. For this fall, we conducted a reconnaissance field trip with Professor Benison and our two new M.S. students Tyler Foster and Molly Kane.

From Mars to Montana: measuring jarosite dissolution rates

Brittany Pritchett[1], Matthew Kendall[1]
[1]*ConocoPhilips School of Geology and Geophysics, University of Oklahoma, Norman ,Okla., USA*

Pure jarosite, ($KFe_3(SO_4)_2(OH)_6$), is a ferric sulfate salt found both on Mars and Earth. The presence of jarosite on Mars provides evidence for a past history of liquid water and can supply valuable information on the geochemistry of ancient fluids. Models for Martian jarosite formation are largely based off of terrestrial analogs and vary widely, including acid saline lake environments and acid mine/rock drainage environments (AMD/ARD). The salt content of water in both environments will reduce the reactivity (activity) of water. Also, in AMD/ARD environments, jarosite can contribute significantly to the natural attenuation of toxic metals through incorporation into the crystal structure (Dutrizac & Jambor, 2000; Smith et al., 2006). The influences of saline environments and toxic metal substitution on the dissolution of jarosite have implications for both Mars aqueous diagenesis and metal fate in AMD/ARD.

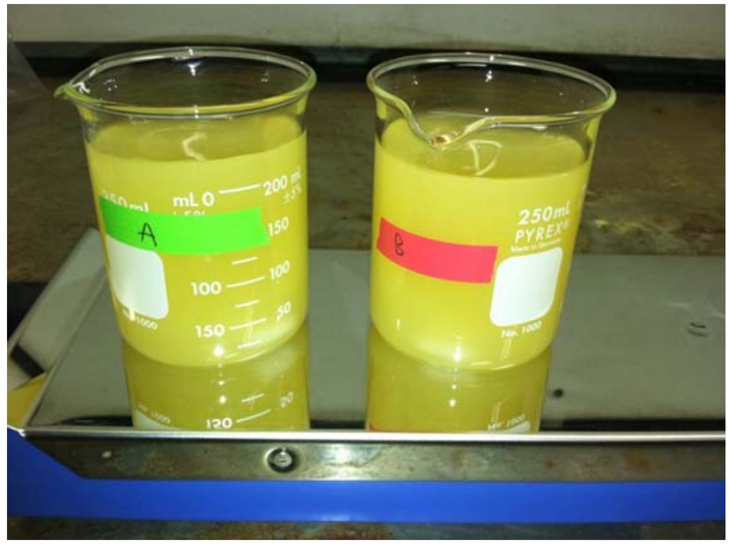


Figure 1. Batch reactor experimental setup.

In order to better understand these influences, pure jarosite and jarosite with incorporated arsenic (0.6%, 2.1%, and 3.7 wt% As) were synthesized in our laboratory. Batch dissolution experiments (Figure 1) were then undertaken to determine the reactivity of pure jarosite in ultra-pure water, NaCl-saturated brine, and $CaCl_2$-saturated brine with an activity of water (αH_2O) of 1.0, 0.75, and 0.35 respectively. Jarosite with incorporated arsenic underwent similar dissolution experiments but in solutions of ultra-pure water and a pH 2 H_2SO_4. Aqueous samples were retrieved at predetermined intervals over several hours and passed through a 0.2 µm filter. All aqueous samples were analyzed for K^+; in addition to K^+ all incorporated arsenic experiments were also analyzed for Fe and As by Atomic Absorption Spectrophotometry. Dissolution rates were subsequently calculated by measuring potassium release over time. Transmission Electron Microscope (TEM) samples were recovered for incorporated arsenic dissolution experiments to help determine the influence of arsenic on reaction products and dissolution mechanisms.

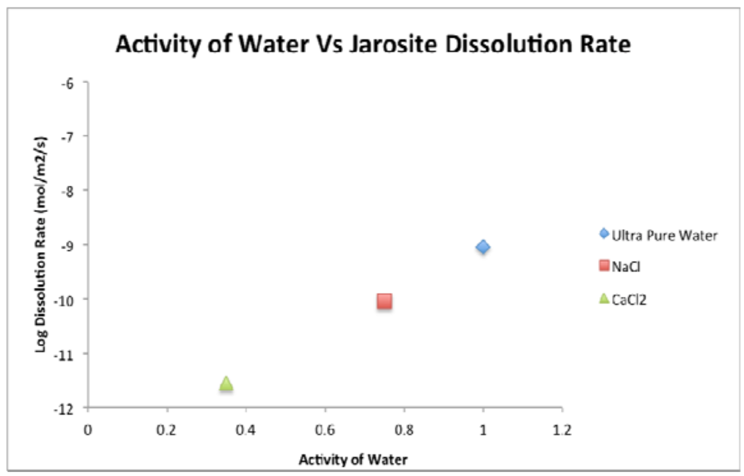


Figure 2. The relationship between pure jarosite dissolution and the different activities of water of ultra pure water, NaCl and $CaCl_2$.

Data show that the rate of jarosite dissolution is affected by the αH_2O (Figure 2). The average dissolution rate for the pure water experiment was approximately $10^{-9.04}$ mol m^{-2} s^{-1}. The pure jarosite dissolution experiments in NaCl-saturated brine (αH_2O = 0.75) produced an average rate of $10^{-10.03}$ mol m^{-2} s^{-1}, while $CaCl_2$ (αH_2O= 0.35) had the slowest of the three dissolution rates with an average rate of about $10^{-11.54}$ mol m^{-2} s^{-1}. These results show that the dissolution rates of pure jarosite decrease as the αH_2O decreases. Using a shrinking sphere model, calculations show that at the three different activities of water (1, 0.75, and 0.35) the lifetimes of a 1mm jarosite particle are 113 years, 1,102 years, and 35,674 years.

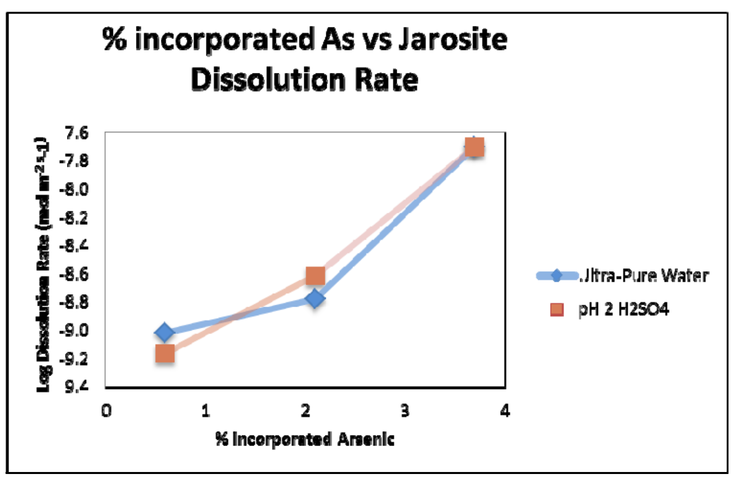


Figure 3. Plot showing the relationship between dissolution rate and the weight percent incorporated arsenic into jarosite in ultra-pure water and pH 2 H_2SO_4 solution.

Jarosite dissolution rates increase with the incorporation of arsenic (Figure 3). In ultra-pure water, dissolution rates for jarosite containing 0.6%, 1.8%, and 3.7 wt% arsenic were 10-9.02, 10-8.78, and 10-7.71 mol m-2 s-1 respectively. Dissolution rates in pH 2 H2SO4 solutions for jarosite containing 0.6%, 1.8%, and 3.7 wt% arsenic were 10-9.17, 10-8.62, and 10-7.71 mol m-2 s-1.

The mechanism of dissolution appears to be a combination of both pitting at impurities and grain boundary retreat along a dissolution front moving into the grain. Thin sectioning and TEM analysis shows that the jarosite grains are not a granular aggregate of jarosite particles but rather are each comprised of a single crystalline particle. Secondary precipitates are observed forming or aggregating along the surface of the grain boundary as well as in solution. The reaction products identified using TEM are maghemite and goethite (Figure 4), consistent with thermodynamic calculations (Figure 5). The reaction products resulting from the dissolution of 2.1 and 3.7 wt% As jarosite appear to be less crystalline and have a smaller crystal size, which may be a result of arsenic "poisoning" the surface and limiting nucleation and growth.

This study shows that the activity of water and incorporation of arsenic have an impact on the dissolution rate of jarosite. Jarosite lifetimes are greatly extended in high salinity systems, allowing for longer periods of aqueous alteration at Meridiani Planum (Figure 6) on the Martian surface. Arsenic incorporation into jarosite enhances the dissolution rate, influences the subsequent reaction products, and should be factored into remedial designs of AMD/ARD systems. These findings provide implications for jarosite dissolution environments on Mars and arsenic mobility in AMD/ARD environments on Earth.

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Dutrizac, J. E. & Jambor, J. L. (2000) Jarosites and their application to hydrometallurgy. In: Alpers, C.N., Jambor, J.L., Nordstrom, D.K. (Eds.), Sulfate Minerals-Crystallography, Geochemistry, and Environmental Significance. Reviews in Mineralogy and Geochemistry, vol. 40, p. 405-452.

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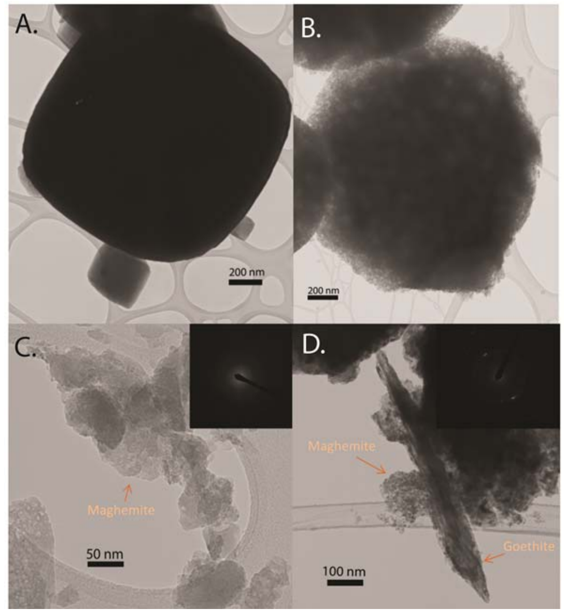


Figure 4. Transmission Electron Microscope images of A) starting jarosite material, B) jarosite after two weeks of dissolution, C) secondary reaction products after 20 hours of dissolution, and D) secondary reaction products after two weeks of dissolution

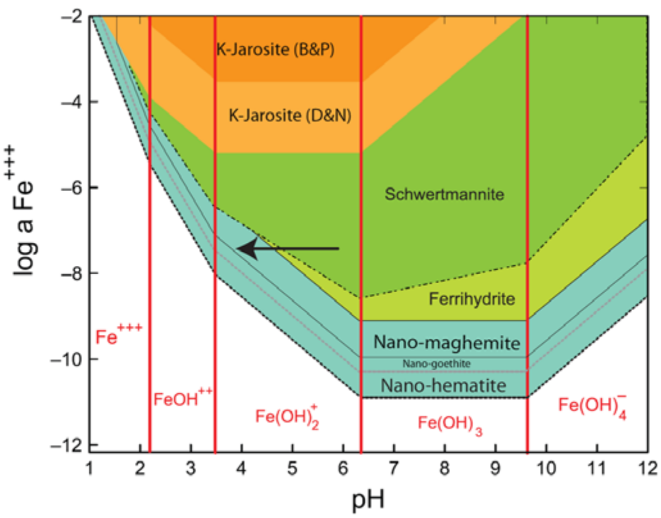


Figure 5. Phase diagram of Fe^{3+}-H_20-SO_4^{2-} system calculated for iron oxides with 10 nm grain size. Arrow indicates approximate reaction path of ultra-pure water dissolution experiments

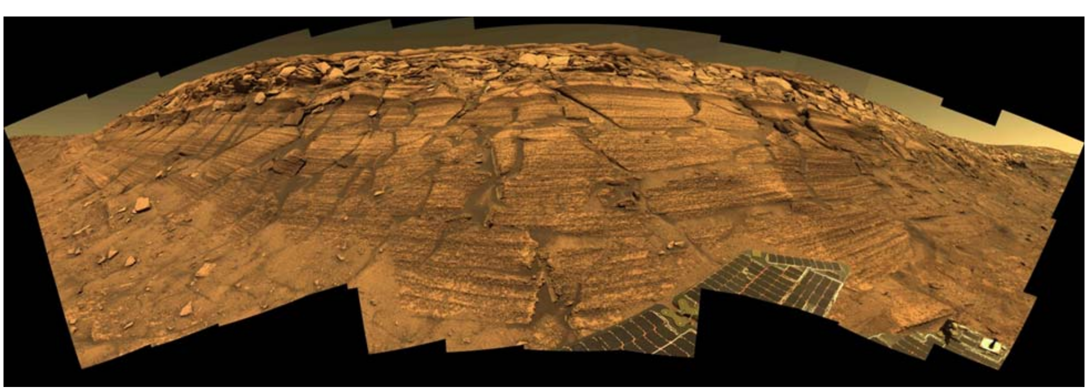


Figure 6. Burns Cliff at Meridiani Planum on Mars, as viewed by the MER Opportunity rover. Burns Cliff contains eolian, interdune/playa sediment, along with jarosite, evaporites, and hematite concretions (McLennan et al, 2005; Arvidson et al, 2007). Image credit: NASA/ JPL/Cornell.

ODES TO MINERALS

As an assignment in creative writing, Professor David London requires that each student in his GEOL 2224 class write a poem or limerick about his or her favorite mineral, which they choose from within the study cases of the teaching collection. Students must research the important properties, locations, uses and lore of their mineral, and weave those elements into their poem. Poems are ranked by class members. The author of the winning poem gets a sample of the mineral that he or she chooses to write about. Here is an example of a former award winner.

David London, Ph.D.

Stubbeman-Drace Presidential Professor *and*

Norman R. Gelphman Professor of Geology *and*

Director, Electron Microprobe Laboratory

TREMOLITE

By Shawn Maroney

Long, long ago when our Earth was still forming
Volcanoes spewed lava and the planet was warming.
Underground it was active more than ever before
As the Earth pumped out heat from deep down in the core.

Great heat met with pressure at a very high level
And extreme interactions seemed the work of the devil.
The violence continued at the surface and deep down
To the point that new atoms were running around.

Some atoms grew attractions to others they found
Until nuclei were formed in which electrons were bound.
Communities were formed to keep them secure
And these became ions, now safe and mature.

As the pressure and high heat pushed up to the crust
The ions excited and started to lust.
Some got together and were instantly paired
While others held back what they had to be shared.

They wanted to have more than just one single friend
So they grouped up with many in hopes to extend.
First silicon and oxygen and hydrogen met
Then calcium came next but there still was room yet.

They looked all around for someone who's just right
'Til they noticed a pair involved in a fight.
Magnesium and iron were duking it out
Until finally one punch put an end to the bout.

The group thought it over and finally decided
Having a strong friend would keep them undivided.
They looked at the one who was still standing up
And magnesium looked back, nodded and joined up!

They looked down at iron as he tried to recoup
And listened to him beg to be part of their group.
They stopped for a moment, considering the thought
And agreed that some color would indeed hit the spot.

So they told him that only ten percent of the time
That he could join them if only to make them more lime.
He agreed that was fair to be there for the ink
That would make them all green and occasionally pink.

So finally the group was complete all the way
Even though it involved a new token cliché.
Iron knew if he ever started a fight,
They would all kick him out, becoming pure Tremolite!

The rules were simple for iron to stay,
He must stick with magnesium every day.
Still iron often found himself in some trouble
So most of the time he was banned from the bubble.

As luck would have it there was another group
That he could go join when kept out of the loop.
In fact they all loved to wrestle and fight,
And this was the group known as Actinolite.

Tremolite and Actinolite, while opposite in style,
Would still sometimes find a way to compile.
They would join with Hornblende and some of the rest,
And meet at the club where they got along best.

Occurring only under certain conditions.
The club was based on metamorphic coalitions.
Only then could they all go out to the pub
Known exclusively as the Amphibole club.

Sometimes the Tremolites would have too much to drink,
Even during those times when they were green or all pink.
They would strip down to nothing and streak late at night,
Where you might see good cleavage as they paint the town white.

As drunk as they were they ran into others,
Like Apatite or Feldspar, or even their mothers.
While running into Apatite never caused any scars,
Bumping into Feldspar hurt enough to see stars.

If this didn't stop them they'd keep drinking more,
'Til their toxicity was so high that they fell to the floor.
And when this was the case they were thrown on a bus
That led straight to jail for harmful asbestos.

In jail for a crime, they were given the right,
To see a slide-show of pictures from last night,
Slides showed their structure as monoclinic,
Their negative way making them quite the cynic.

Also they saw in the very next slide,
Their pleochroism was even denied.
Driving last night was just so unideal,
Even when they were driving the biaxial.

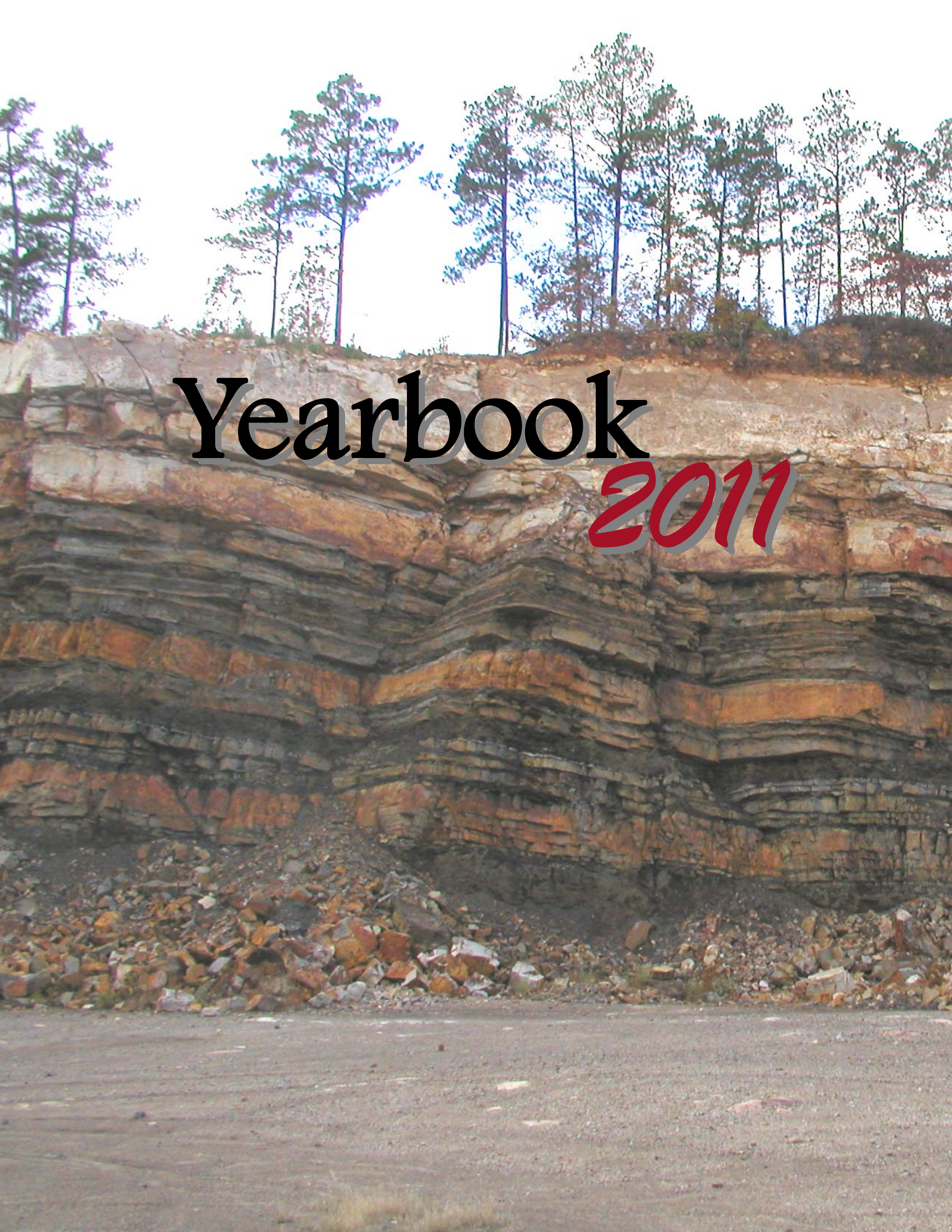
Due to the crime the sentence was harsh,
They were burned really bad then thrown in the marsh.
Burned at high temps, they screamed and they cried,
Knowing that soon they'd become Diopside.

For those of the group that always kept clean,
They were given the chance to shine very green.
Known as Nephrites, they never betrayed,
Their life was quite nice, being that they were Jade.

Often they hung out with large groups of friends,
And not just their silicate family's ends.
Calcite and Talc are associations,
Serpentine and Grossular also have relations.

Tremolites often believe they transcend
From the Tremola Valley in Switzerland.
But this is quite far from the truth actually..
Since they're really from Campolungo, Italy.

First C-A-two, and then M-G-five,
Then this is where some F-E may survive,
Now S-I-eight, and O-twenty-two,
Last O-H-two; I-M-A approved!


Yearbook
2011

State of the School

As presented to the Alumni Advisory Council, November 4, 2011,
by Doug Elmore, Director

http://www.ou.edu/mcee/geology.html

Current Faculty Status:

- 9 Full-Time Tenured Faculty
- 3 Full-Time Tenure Track Assistant Professors
- 1 Ranked Renewable Term

Vacancies

- Petroleum Geologist
- Geophysicist

Both searches are under way. Will invite candidates in the spring.

TEACHING

- The faculty taught an average of four courses/year in 2010-2011.
- We also do our share in terms of students taught and credit hours.
- On average, CPSGG faculty teach over 500 credit hours/year, which is equal to about 170 students.
- We teach many undergraduate General Education courses – about same as MPGE and better than most other science and engineering units at OU.

STUDENTS

- Students receiving AAPG Grants-in-aid: Sarah Farzaneh, Nabanita Gupta, Malleswara Yenugu
- Working on new web page
- Satellite writing center in Energy Center for CPSGG students
- TV in west atrium with news and events about the school; Started to add content

Field Camp

The new Bartell Field Camp

Both Geology and Geophysics courses

Official Opening – June 11

Fieldtrips

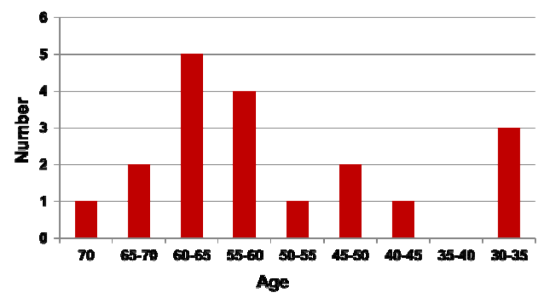
Galveston, Permian

Reef West Texas, Arkansas,

Florida Keys, Death Valley, etc.

Freshman trip 2011 = 16 students

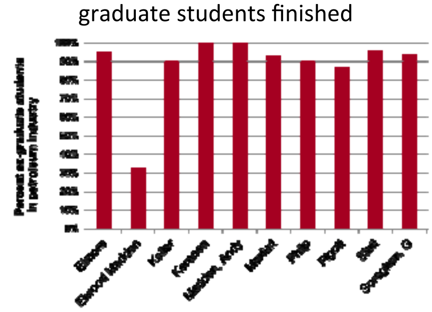
CPSGG Faculty Age Distribution (2011)



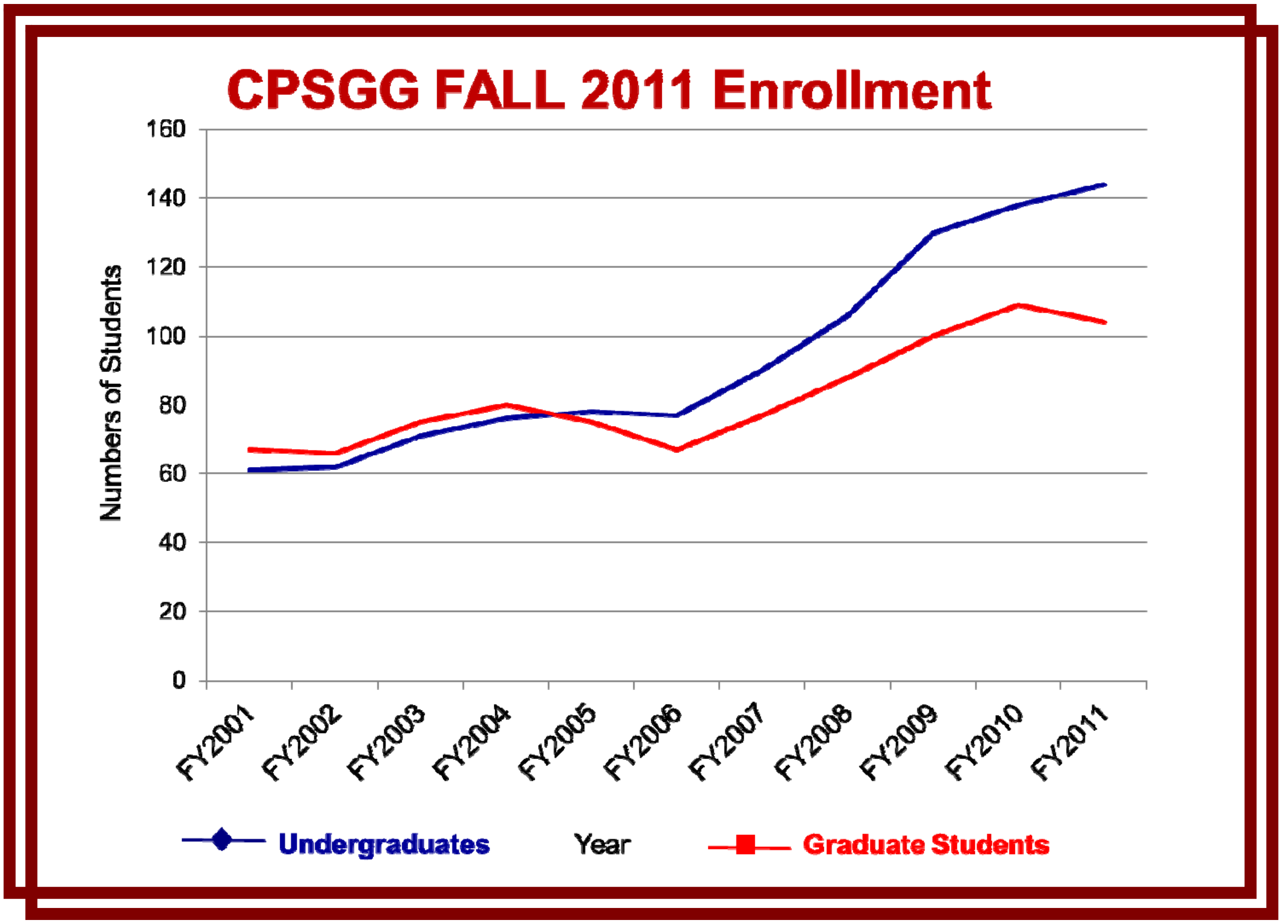
Challenge - Eight faculty are eligible to retire in five years.

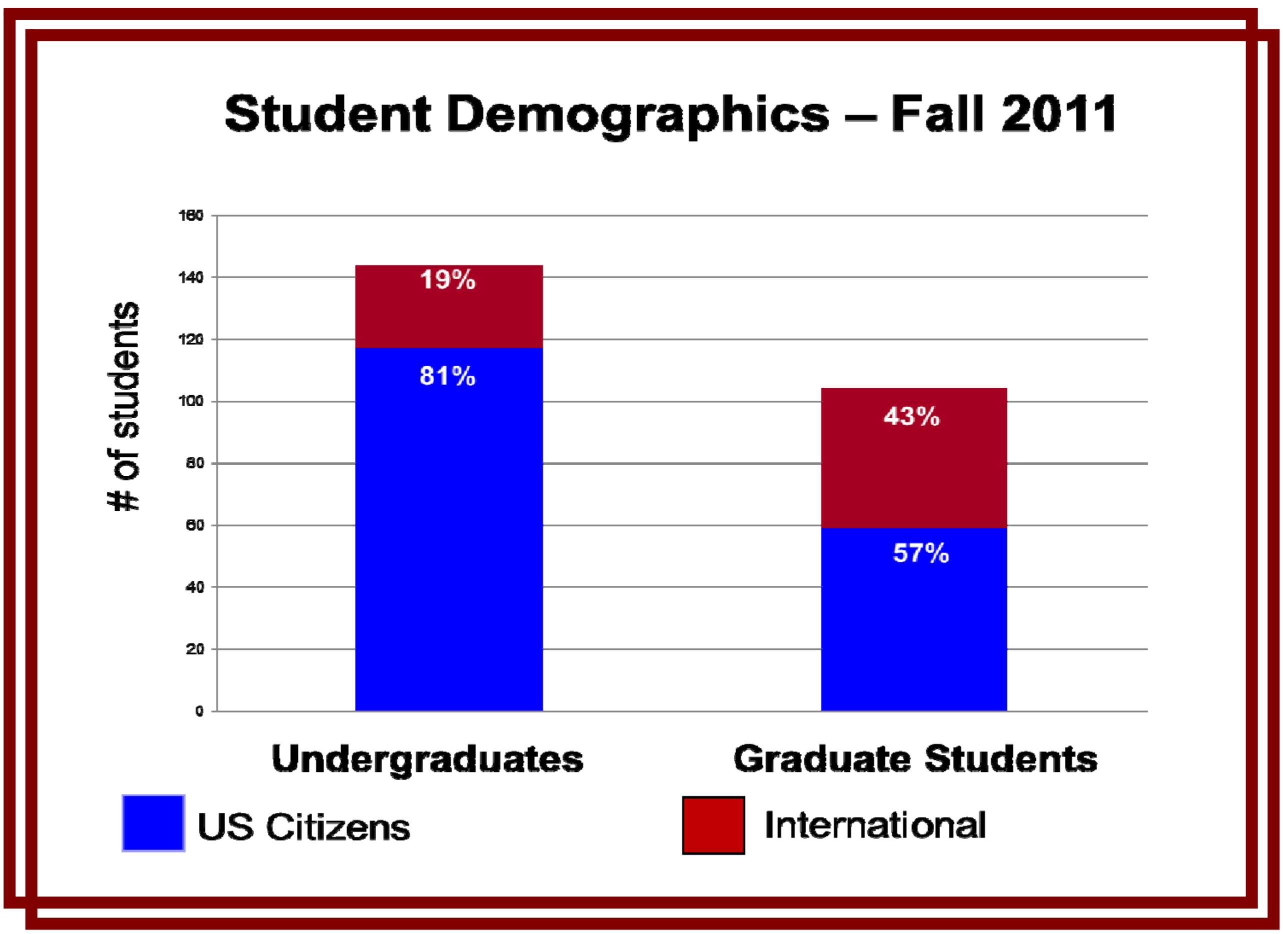
Percent ex-graduate students working in the petroleum industry*

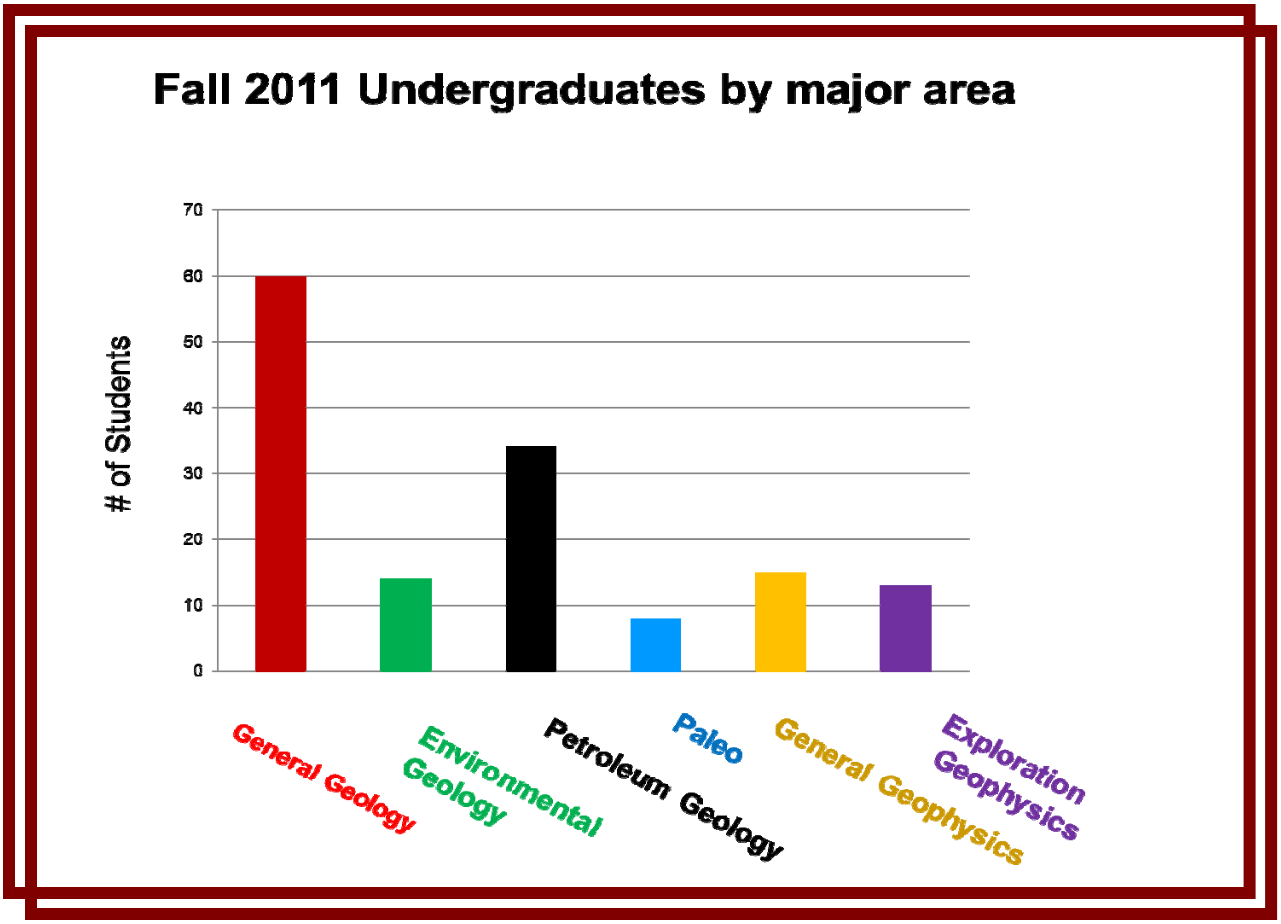
Number at top of column = total graduate students finished

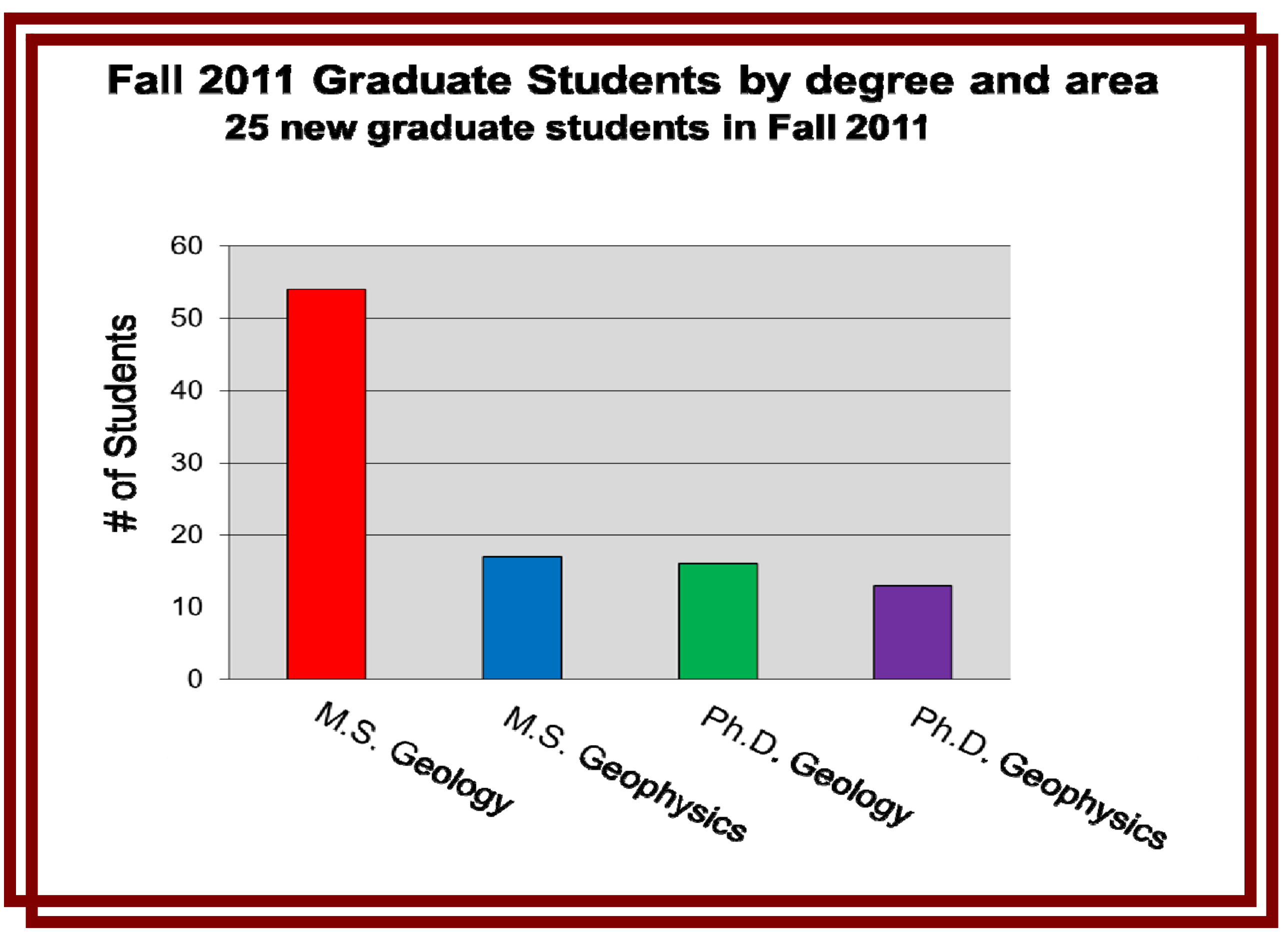


* Note: Not all faculty responded to request for information


CPSGG FALL 2011 Enrollment
160
140
120
100
80
60
40
20
0
Numbers of Students
FY2001
FY2002
FY2003
FY2004
FY2005
FY2006
FY2007
FY2008
FY2009
FY2010
FY2011
Undergraduates
Year
Graduate Students


Student Demographics – Fall 2011
# of students
160
140
120
100
80
60
40
20
0
19%
81%
43%
57%
Undergraduates
Graduate Students
US Citizens
International


Fall 2011 Undergraduates by major area
# of Students
70
60
50
40
30
20
10
0
General Geology
Environmental Geology
Petroleum Geology
Paleo
General Geophysics
Exploration Geophysics


Fall 2011 Graduate Students by degree and area
25 new graduate students in Fall 2011
# of Students
60
50
40
30
20
10
0
M.S. Geology
M.S. Geophysics
Ph.D. Geology
Ph.D. Geophysics

RESEARCH PROJECTS

Attribute-Assisted Seismic Processing and Interpretation (15 companies, Marfurt)

Geophysics of the Barnett Shale **(Devon Energy, Marfurt)**

Integrated Stable Isotope Analysis **(DOD, Philp)**

Dust as an Archival Agent in Late Paleozoic Pangea **(NSF, L. Soreghan/M. Soreghan)**

Potential Impacts of Anthropogenic Change on Shell Beds of Lake Tanganyika Grant-in-Aid of Research **(NGS, M. Soreghan)**

Research Planning Visit: Investigating High-Latitude Climate Change Recorded in Upper Paleozoic Non-Marine Strata of East Africa **(NSF, M. Soreghan)**

PIRE – U.S.- China Partnership **(NSF, Keller)**

Permian Redbeds of the Midcontinent **(NSF, M. Soreghan and L. Soreghan)**

Broadband Recording at the Site of Great Earthquake Rupture, SW Alaska **(NSF, Keranen)**

Pathways to Mars Analogue Hematite through Nanoparticle Aggregation **(NASA, Andy Madden and Megan Elwood Madden)**

Collaborative Research: Exploring Extensional Tectonics Beyond the Ethiopian Rift **(NSF, Keranen)**

Analysis of Fault Processes **(NSF, Reches)**

Shale Pore Networks Consortium **(8 companies, Slatt)**

Energy Libraries On-Line **(Marathon, Keller)**

Seismic Stratigraphy **(Kuwaiti National Oil Company, Pigott)**

Water and Carbon Reservoirs: Gas Hydrates on Mars **(NASA, Megan Elwood Madden)**

Jarosite Lifetimes on Mars **(NASA, Megan Elwood Madden and Andy Madden)**

Poromechanics Consortium **(Numerous companies, Abousleiman)**

Pacific Northwest Case Study **(NSF, Keller)**

Collaborative Research: Foreland Basin Development and Biotic Change in Late Ordovician Trilobite Faunas of Eastern North America **(NSF, Westrop)**

Nano Diamonds **(NSF, Andy Madden)**

Powe Research Award - Advanced Gravity and Magnetic Analysis of the Alamo Crater, Nevada **(ORAU, Keranen)**

New XRD and Mineral Analysis **(Devon Energy, Andy Madden and Elmore)**

Diagenesis of the Marcellus Shale **(Devon Energy, Elmore)**

Integrated Depositional and Diagenetic Study of the Mississippian Limestone in Oklahoma **(Devon Energy, Elmore)**

Garnet-Biotite-Tourmaline Thermometry at High Mn Content **(NSF, London)**

Assessing the Geologic History of Unaweep Canyon through Continued Geologic Mapping **(USGS, L. Soreghan)**

U.S.-France Planning Visit: Investigating Upland Glaciation in the Pangaean Tropics **(NSF, L. Soreghan)**

Fifteen faculty hold significant grants.

Classes of 2011-2012

Master of Science in Geology

Christopher D. Althoff
Sunday O. Amoyedo
Henry A. Badra
Charles Baker
Tristan N. Barker
Yuval Boneh
Andrea F. Cadena Mendoza
Carlos R. Ceron
Adam R. Chain
Matthew V. Cleveland
Ryan C. Davison
John Deng
Stacey C. Evans
Seth R. Gainey
Brandon M. Guttery
E. Matthew Hamilton
Katie M. Hulsey
Ryan C. Jordan
Matthew R. Kendall
Shanshan Liu
Guillermo A. LoMonaco Carias
Andrea M. Magoon
Earl B. Manning
Matthew A. Miller
David K. Moss
Justin K. Newman
Levi B. M. Pack
Elisheva M. Patterson
Kerry A. Paul
Brittany N. Pritchett
Margaret J. Root
Marcelo Sanchez Vargas
Brett D. Schlichtemeier

Master of Science in Geophysics

Alejandro Cabrales Vargas
Catherine M. Cox
Yavus O. Ellis
Shiguang Guo
Christopher G. Mace
Aliya M. Urazimanova
Hulya Yilmaz

Bachelor of Science in Geology

Abdullah Abduljalil Alabbad
Austin L. Bristow
Stephanie I. Cole
Olamide Femi Dada
Emily M. Dixon
Thaddeus M. Eccles
Justin V. Haynes
Maxwell J. Hollman
Rebecca L. Johnson
Clark A. Packard
Virginia G. Priegnitz
Shayda K. Zahrai

Bachelor of Science in Geophysics

Ahmed T. Alawami
Ahmed Naseem Al-Dawood
Amjad M. Alzawad
Dustin T. Dewett
Cullen M. Hogan
John R. Leeman

Doctor of Philosophy in Geology

Jesse R. Carlucci
Nabanita Gupta
Tarek A. O. Hodairi
Zonghu Liao
Norelis D. Rodriguez Maiz
Supratik Sarkar

AAPG Student Chapter

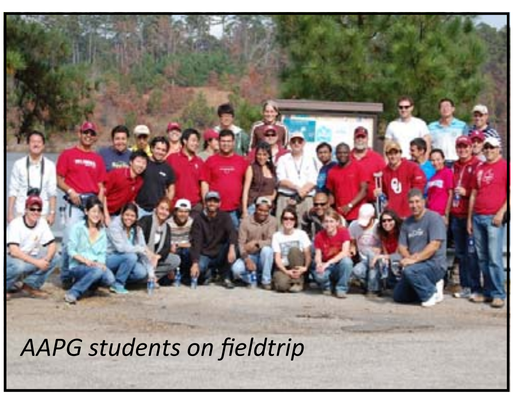
ConocoPhillips School of Geology and Geophysics
The University of Oklahoma

Year-End Report

2011-2012 OFFICERS

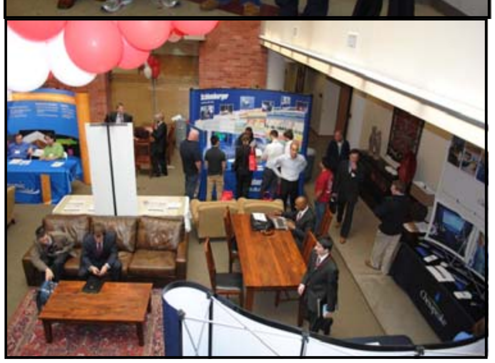
•Emilio J Torres. President. M.Sc. Geology student
•Bagdat Toleubay. Vice President. B.Sc. Geophysics student
•Andrea Cadena. Secretary, M.Sc. Geology student
•Melia Da Sliva. Treasurer. M.Sc. Geophysics student

This year, we have many new and exciting things going on with our AAPG Chapter along with many of the other activities that have helped make our chapter one of the strongest in all of AAPG worldwide. These events include technical short courses, lunch-n-learns, field trips, video conferences with international student chapters and other social activities. We provide many different ways to get involved with the School of Geology and Geophysics as well as many of the oil and gas companies. We also are excited to continue our legacy events, the AAPG Talk Exchange, a student speaker series throughout the year where our students present in an informal setting to their peers as a form of information transfer within our organization; and our third Alumni/student Golf Tournament, which is a social event to interact with the student and industry community.



AAPG students on fieldtrip

Our student chapter is very diverse in terms of its membership. We have more than 80 members with a very good mix of geologists, geophysicists and petroleum engineers from both undergraduate and graduate programs. Our main goals are to promote fellowship within the department and give our members various skill sets that they can transfer over to the petroleum industry.



Events/Awards

AAPG/SEG Spring Break Student Expo 2011

- 16 sponsors, 160 students attended, 14 companies interviewed, 69 posters
- Brett Schlichtemeier– third place Geophysics poster

SEG Challenge Bowl

- First place at regional meeting – Brett Schlichtemeier and Murari Khatiwada

Imperial Barrel Competition

First-place team at 2011 SEG Challenge Bowl

– Second place in region 2010 and 2011

The AAPG Student Chapter won the outstanding chapter award at the 2010 AAPG Meeting in New Orleans

Fall 2010 Recruiting – 25 companies

AAPG students receive the Student Chapter of the Year Award

PICK AND HAMMER CLUB

Members of the Pick and Hammer Club get ready for the 2011 OU Homecoming Parade. From left: Gaurang Patel, Andrew Swindle, Jamie Miller, Matt Miller, Virginia Priegnitz, Matt Kendall and Tad Eccles.

Follow "OU Pick and Hammer" on Facebook!

Events

Mineral Auction – 4 Nov 2011

Diamond Hunting – 11 Nov 2011

Children's Haven Gift – Christmas 2011

Tucson Mineral Show – Jan 2012

Drill Rig Tour – Spring 2012

And more!

Pick and Hammer is proud to be among the oldest student organizations on the OU campus. Founded in 1903 on a field trip to the Arbuckle Mountains by seminal OU geology professor Charles N. Gould, Ph.D., the club offers constructive geologically oriented social activities for interested students, be they majoring in the geosciences or pursuing other studies. The 2011-2012 year was, and is, packed with exciting activities, including Pick and Hammer's annual fundraiser auction at the Oklahoma Trailblazer Awards Dinner, marching in the OU homecoming parade, a diamond-hunting trip to Arkansas, local charity work, and more! Interested in Pick and Hammer membership? Contact the club officers via email at pickandhammer.ou@gmail.com.

PICK AND HAMMER CLUB

We sincerely appreciate your support of Joplin kids after the tornado! We have an area on our playground where the kids frequently find treasured rocks. They would have loved the mineral auction.

Children's Haven
Home for children.
Help for families.

Dear Pick & Hammer Club,

On behalf of the children and families we serve, thank you for your 2012 monetary donation of $600. Through the service we provide, our goals are to protect children, prevent child abuse and neglect and reduce family stress. We do this by providing a safe and secure home for children while parents resolve the crisis at hand.

In 2011, Children's Haven provided 2,814 shelter nights for 373 children when their families faced crisis of various types. Because our services are offered free of charge to local families, your contribution will help ensure that we can continue to provide food, shelter and nurturing care to area children when they need it most.

Children's Haven is a non-profit, charitable organization and your donation is tax deductible (Federal Tax ID # 04-3603881). We appreciate your support of our mission, and welcome you to visit Children's Haven. To set up a tour, please contact me at childrenshaven@att.net or (417)782-4453. Be sure to check out our website at www.childrenshaven-swmo.org, Facebook page and retail registries for updated children's wish lists throughout the year.

Sincerely~
Stephanie Greis

Pick and Hammer Giving to the community

The Pick and Hammer Club held its annual mineral auction in November 2011 at the Fall Alumni Meeting. The club gave 10 percent of the proceeds from the auction to Children's Haven in Joplin, MO., an organization dedicated to helping children and families in the southwestern portion of Missouri for the past nine years.

The donation to the organization came at a wonderful time to help kids in the Joplin area recover from the May 2011 tornado. Children's Haven sent the card shown at left to the club in appreciation of their support and thoughtfulness.

2011

SCHOOL EVENTS AND STUDENT ACTIVITES

2011 Back-to-School Mixer

Thunderbird Lake, Clear Bay Café

AAPG-sponsored relay team in Oklahoma City marathon

The Quartz Cowboys took second place in the college division of the Oklahoma City Memorial Marathon, with a time of 3:27:50.

Team members were (from left): Allison Stumpf, Andrea Magoon, Alaina Jones, Brett Schlichtemeier and Chelsea Jones.

BIG EVENT

Last April, 20 members of the CPSGG were involved in the Big Event, OU's campuswide day of community service. We went to Ridgeview Elementary School in Oklahoma City and helped repaint the gymnasium, rake up leaves and trash, and did some landscaping.

2011 AAPG/SEG Spring Break Student Expo

2011 Homecoming

Know Your Council Members

www.ougeoalumni.com

(Executive Council highlighted in red)

Alumni Advisory Council

Gerald R. Allen
Robert W. Allen
James K. Anderson
Gregory J. Appleton
Tommy H. Atkins
Carlos "Tex" Bahamon
Rachel Barber
J. Denny Bartell
Elizabeth "Lisa" Baruch
A.E. "Al" Basinger, Jr.
Clyde Becker. Jr.
Doug Bellis
Edward F. "Ted" Benson
Brad Biddy
Angela M. Blumstein
Raleigh Blumstein
Charlie Bolt
Gabriel Borges
David G. Campbell
Kelvin D. Cates
James E. Caylor
Chris J. Cheatwood
David Childers
Patrick H. Clare
William W. Clopine
Robert Cook
T.D. "Tommy" Craighead
Andrew Cullen
Douglas R. Cummings
Stanley L. Cunningham
Bob Davis
Thomas E. Davis
John Delaughter
Rodger E. "Tim" Denison
John R. Dewey
Joseph D. Dischinger
Marlan Downey
Dan Earl Duggan
Mica Feinstein
Dave Fleming
Dick French
Douglas H. Freeman
James A. Gibbs
M. Charles Gilbert
R. Vance Hall
Harold Hanke
Joe Hayden
Gene Heape
Robert A. Hefner, IV
Gerald M. Heinzelmann, Jr.
Diego Hernandez
Owen R. Hopkins
Jeff Kelley
Kent Keller
Jennifer L. Kessler
Claren Kidd
John Kinard
Rick Kistler
Eric Kubera
Graydon H. Laumbaum
Emmitt S. Lockard
Donald R. Massad
J. James McKenny
Cameron R. McLain
John B. McNeely
Tom Meason
Gerard J. Medina
Galen Miller
Sharon D. Minor
Kerry M. Moreland
Jerome Murphy
Kenneth J. Nelson
Clayton Nichols
Charles R. "Chuck" Noll, Jr.
Brian E. O'Brien
Kate D. Patrick
H.W. "Dub " Peace, II
Hugh E. Peace
Jeanne Polk
Jon R. Withrow
Michael Anthony Pollok
Bill K. Reed
Joe Rison
Suzanne M. Rogers
Aaron Rothfolk
T.L. Rowland
Carlos Russian
Deborah K. Sacrey
Daniel Samake
Lealon L. Sargent
William P. Siard
Roger M. Slatt
Katherin J. Sokolic
Robert L. Stephenson
Gary Stewart
John Taylor
Gene Van Dyke
Staffan Van Dyke
Joe T. Vaughn
Cyril Wagener, Jr.
Douglas Wight
Patrick O. Williams

OFFICERS 2011-2012

Chair—Sandra Minor
Vice Chair—Brad Biddy
Secretary—T.D. "Tommy" Craighead

DIRECTORS

Harold Hanke
Gerard J. Medina
Kate D. Patrick
Patrick H. Clare
Rodger Denison
Joe T. Vaughn

In Memory of Our Alumni Who Have Passed

Roy Almond
Patrick Andrews
Joy Anneler
Donald Becker
Clifton Blanks
Horace Brewster
Robert Cape
William Capps
Mary Carruth
Robert Chancellor
Steven Cochran
Harold Conrad
James Cowan
James Curtis
Myron Dickson
Linus Dinges
Kenneth Dixon
W. Fields
Paul Fister
Jim Harris
Jerry Haston
Owen Hopkins
Alexander Hruby
David Hurst
Lawrence Indergard
Donald K. Jones
L. Kirkpatrick
Robert Klinko
Gordon Knox
Joseph Lintz
Vera Magill
Thomas Matson
Joe McGarrah
Glenn McKinley
V. McLamore
Carey Miller
Ernest Miller
Virginia Nelson
Jamie Querry
Don Rector
Charles Reynolds
Billy Riddle
Edward Ries
Truman Saunders
Hubert Skinner
Theodore Solarz
Francis Stewart
Frayne Toll
Cyril Wagner
Robert Wynne

Reported as of January 2012