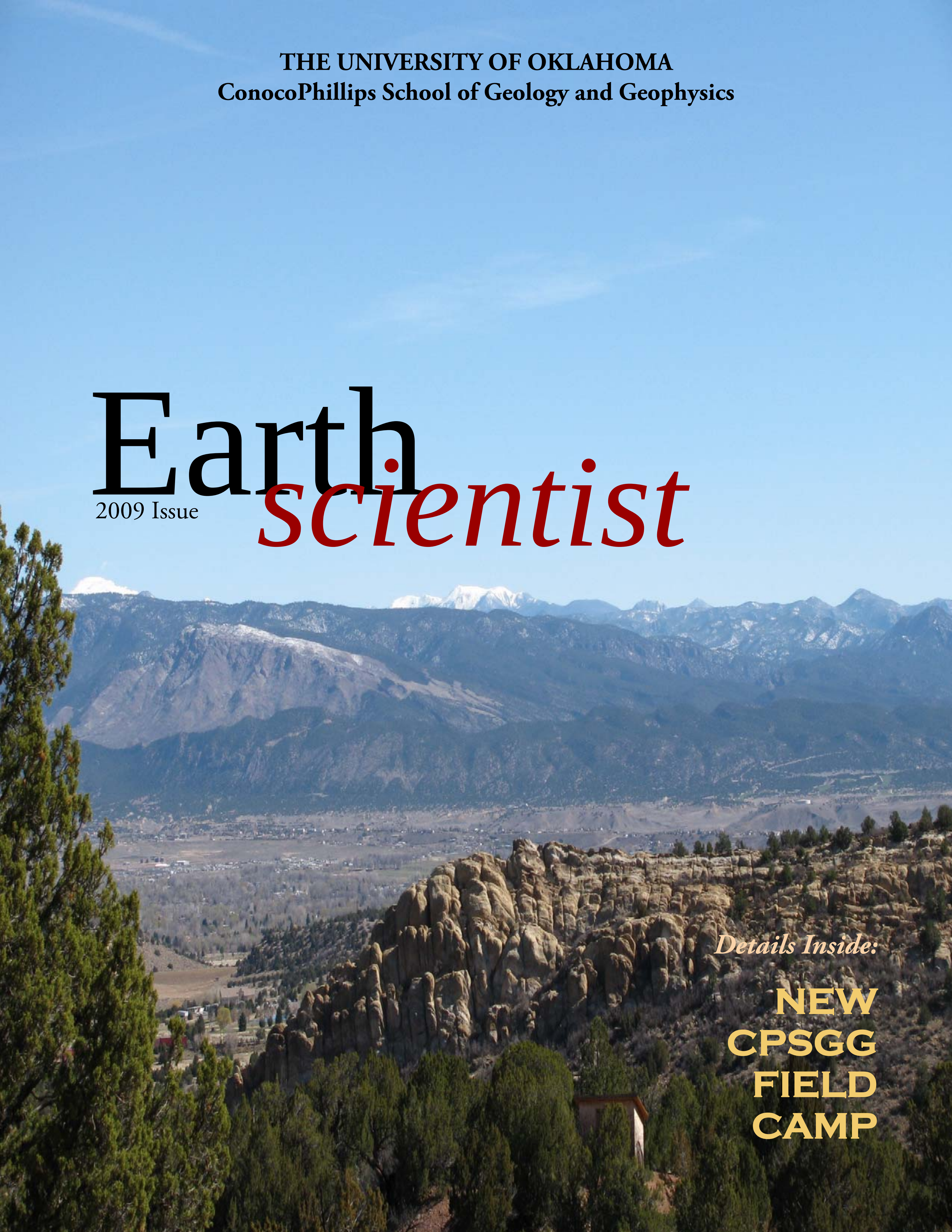
THE UNIVERSITY OF OKLAHOMA
ConocoPhillips School of Geology and Geophysics

Earth *scientist*

2009 Issue



Details Inside:

NEW CPSGG FIELD CAMP

Painting by Carol Armstrong, Native Oklahoma Artist

ABOUT THE ARTIST:
Carol was raised in Prague and attended the University of Central Oklahoma, where she received a BS in Fine Arts. She has lived in Norman for over 26 years and is sought after for her artwork as well as her teaching, which has a devoted following of students at the Firehouse Art Center.

EDITOR/LAYOUT/DESIGN
Niki Chapin

REVIEWERS
Neil Suneson
Naïla Williams

CONTRIBUTORS
SGG Students
SGG Faculty
SGG Alumni
Photos by Rachel Barber

ABOUT THE COVER: (front) view of Pikes Peak standing in the main camp grounds of the soon-to-be CPSGG Field Camp; (back) view from the high camp looking down on the main camp—proposed locations for the cabins and dining hall are labeled.

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 Niki Chapin, ConocoPhillips School of Geology and Geophysics, 100 East Boyd Street, 710 Sarkeys Energy Center, Norman, OK 73019-0628.

Earth Scientist

Table of Contents

The University of Oklahoma®

OFFICE OF THE DIRECTOR
CONOCOPHILLIPS SCHOOL OF GEOLOGY AND GEOPHYSICS

October 12, 2009

Dear Alumni and Friends,

I am writing to let you know about an exciting new development at the University of Oklahoma ConocoPhillips School of Geology and Geophysics. Because of the generous support of Denny Bartell, a 1954 geological engineering graduate, we are in the process of purchasing land so we can build our own field camp in the Cañon City, Colorado area.

You may recall that prior to 1983 we shared the old camp northwest of Cañon City with Oklahoma State University. In 1983, OU established its own field camp in rented facilities at the Holy Cross Abbey in Cañon City. We used the Abbey until 2006, when it was sold and turned into a winery. At that time, we teamed up with OSU at their camp as a short-term solution. We provide faculty and curriculum, but the camp belongs to OSU.

One hallmark of a premier geology program like ours is to have its own field camp. This allows us to manage and control our own success and gives us a competitive advantage among our peers. It also gives the entire University a facility for research and retreats.

We have been very fortunate to identify an 86-acre property to the south of Cañon City in the Wet Mountains. This location is ideal for a number of reasons: It's in a secure gated area with one-way access, the site backs up to National Forest land, and it's near OU's current mapping areas. It is really quite a beautiful place, with great views of the Cañon City embayment and Pikes Peak. There also are good building sites for the dining hall, cabins, bath houses, and parking, and a location for a campsite higher in the mountains.

We have received approval from President Boren to move ahead with the project and, with Denny Bartell's gift, we are now working to purchase the land. The owner of the 86 acres, who has expertise in building for mountain locations, has agreed to build the camp structures. If we can begin very soon, the camp will be ready by Summer 2010.

The Field Camp project has strong support from our faculty and students, and, also, our alumni, who have such enduring memories of their own field camp experience. That's why I wanted to be sure everyone was aware of these recent developments as we work to complete construction funding. We are developing some neat naming opportunities – from naming a cabin to naming a rocking chair.

If you have questions or concerns, please call me at 405-325-4493 or Ameil Shadid, Development Officer for the Mewbourne College of Earth and Energy, at 405-325-0463.

Sincerely,

R. Douglas Elmore

R. Douglas Elmore, Director and Eberly Professor
ConocoPhillips School of Geology and Geophysics

710 Sarkeys Energy Center
100 East Boyd Street, Norman, Oklahoma 73019-1009 U.S.A.
PHONE: (405) 325-3253 FAX: 325-3140

THE UNIVERSITY OF OKLAHOMA

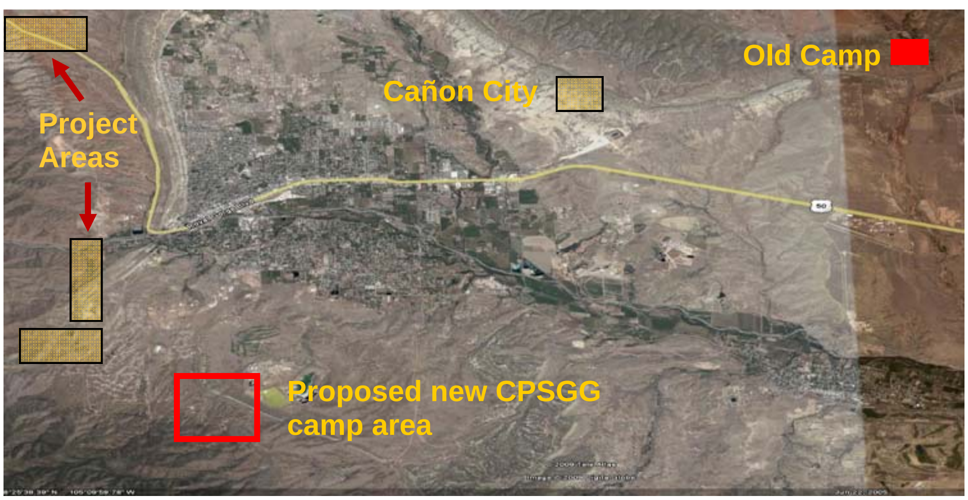
ConocoPhillips School of Geology and Geophysics

Pikes Peak—view to north from main camp

NEW CPSGG FIELD CAMP

New OU Field Camp

Cañon City , Colorado



WHY DO WE NEED A NEW CPSGG FIELD CAMP?

Seniors in the ConocoPhillips School of Geology and Geophysics currently go to the OSU Field Camp near Cañon City, Colorado for their capstone course. Prior to 2006, we ran our own camp and stayed at the Abbey in Cañon City. In 2006, it was sold and we had to find another location. While we provide faculty and curriculum for the camp, we need our own camp so that we have control of the education of our students. A premier geology program should have its own camp.

WHAT DO WE NEED?

- An estimated $2 - $3 million
  - Approximately $1.2 million to buy land and construct buildings
  - $1-$2 million endowment (40 - 80k per year)
    - ⇒ Emergency fund, shore-regional trip
    - ⇒ Director, faculty salaries, expansion

WHAT DO WE HAVE?

- Approximately $1,100,000 from Denny Bartell and a few other donors.
- Denny Bartell will match up to $400,000 more in donations.
- Approximately $125,000 in other committments

ESTIMATED SHORTFALL

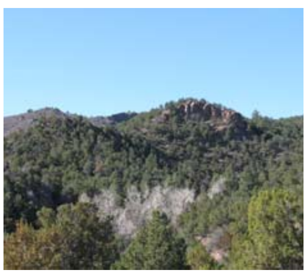
- We need approximately $575,000 more (for $1 million endowment)

MULTI-PURPOSE CAMP

Other departments at OU could "rent" the camp.
Faculty / Staff could use for Retreats.
Intro Geology for Freshman—Good recruiting tool.
We are also in discussions with the University of Tulsa about their Geology students attending our camp.

NAMING OPPORTUNITIES

10 4-student cabins with porches; 6 cabins with baths for faculty/visitors



Trails and area landmarks (view from Main Camp up to High Camp)

Includes a trip to the shore or a regional trip to Wyoming and Montana

Dining / Kitchen / Study Hall
- *Minimum $750,000*

Deck on Dining Hall
- *$15,000*

10 Cabins 14' x 14' w/6' Covered Porch
- *$30,000 each*

Women's Bath House
- *$50,000*

Men's Bath House
- *$50,000*

6 Faculty/Visitors Cabins w/Baths
- *$50,000 each*

Trails and Landmarks
- *$2,000*

High Camp Structure
- *$10,000*

Rocking Chairs for all Cabins w/Decks
- *$1,000*

Study Hall 20' x 24'
- *$100,000*

Solar Panels
- *$15,000*

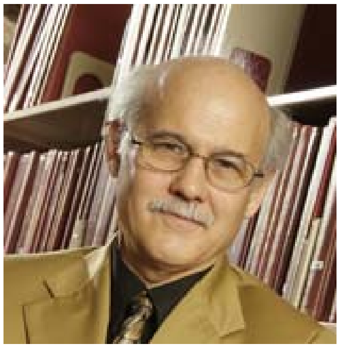
Shore / Regional Trips
- *$100,000*

TOTAL $1,722,000

IF YOU WOULD LIKE ADDITIONAL INFORMATION OR IF YOU WOULD LIKE TO ARRANGE FOR A MEETING AND A PRESENTATION ON THE FIELD CAMP, PLEASE CONTACT DOUG ELMORE AT 405-325-4493 OR DELMORE@OU.EDU

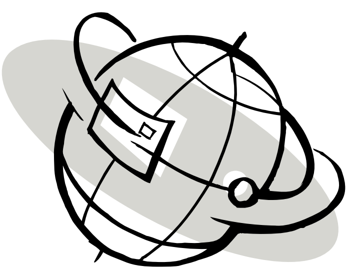
R. Douglas Elmore

DIRECTOR'S CORNER



Director, ConocoPhillips School of Geology and Geophysics and Eberly Family Chair Professor; Associate Provost

Visit our Web site at:
http://geology.ou.edu



The 2008-2009 academic year has been another eventful one in the ConocoPhillips School of Geology and Geophysics. Perhaps the biggest news is the acquisition of land and approval to build our own field camp, which you can read about in my letter to alumni and friends on page 1 and in the brief summary starting on page 2.

In August of 2009, a new junior level faculty member, Katie Keranen, joined our ranks in the continuing effort to build up our geophysics program. Katie has a Ph.D. from Stanford, worked as a geophysicist for ExxonMobil for several years, and most recently has been on a postdoctoral fellowship with the USGS. Kurt Marfurt and Randy Keller will introduce her at the AAC meeting this fall in November.

Our undergraduate and graduate enrollments continue to increase. Last Spring our graduate recruiting initiative paid off and approximately 30 new graduate students joined us this fall. We now have over 100 graduate students. Our recruitment plan for undergraduates is also working well with over 128 majors. This year we increased the scholarship amounts and number of undergraduates receiving scholarships thanks to generous donations from our alumni.

Other notable events:

- Dr. Randy Keller accepted the position as Director of the Oklahoma Geological Survey (OGS). Randy is now half-time in CPSGG and half time with OGS. This will facilitate developing better relations between CPSGG and the OGS.
- External funding increased from below $1 million in FY05 to almost $3 million in FY08.
- Last fall, we had 31 companies interview on campus; and this fall, we expect about 25. Our students continue to get jobs. The AAPG/SEG Spring Break Student Expo was successful, although there was not as much activity as in past years. Brad Wallet and Oswaldo Davogustto won the regional SEG Sooner Challenge Bowl competition and will represent OU and the central region at the national convention in October, 2009.
- We purchased two new vans for field trips.
- Five students placed second in the AAPG regional Imperial Barrel Competition. Team members included: Andrea Miceli, Diana Parada, Oswaldo Davogustto, Byron Solarte, and Jonathan Funk. Their advisors were Roger Slatt, Kurt Marfurt, and Larry Grillot.
- Several of our students won awards in the last year. Amanda Rondot received the DeGolyer Fellow award. Matthew Zechmeister was one of about 15 students from around the country who won a research award from ExxonMobil. Francy "Natalia" Leon Diaz received the Outstanding Student award from the Tulsa Geological Society.
- Adrianne Fox, one of our staff members, was awarded the Hourly Employees Distinguished Performance Award from the University.
- Neil Suneson, Rick Andrews, and Dan Boyd from the OGS offered the undergraduate course, Subsurface Methods, again last year and had nine students.
- In collaboration with the English Department and the Writing Center at OU, we have started an initiative to improve the writing ability of our undergraduates. Rather than have our students take a Technical Writing course in the English Department, we are now offering a GeoWriting course taught by Megan Elwood Madden, with help from a Writing Fellow from the OU Writing Center. We have also arranged with the Writing Center to have a satellite "Writing Center" in the Energy Center where our students can get help with writing several times a week.
- In addition to the courses we teach for our majors, the CPSGG faculty members continue to teach about 1400 students in introductory general education courses as well as courses for MPGE and the Business College.
- In the spring, Barry Weaver, Gail Holloway, and I ran the freshman field trip to New Mexico and Colorado. Fifteen students went on the trip, and it was a big success.
- At our spring picnic and honors event, several students received awards. See pages 5 through 8 for the "Who and What."
- Some of you may remember the large geologic map of Oklahoma that was hanging between the second and third floors in the stairwell at the southwestern corner of Gould Hall, our old building. Gould Hall is undergoing a major renovation for the College of Architecture, and with the help of several students, we rescued the map. It is in pretty good shape for a 1938 map. We plan to hang it in the Energy Center and are currently looking for a good wall.

R. Douglas Elmore

DEAN'S CORNER

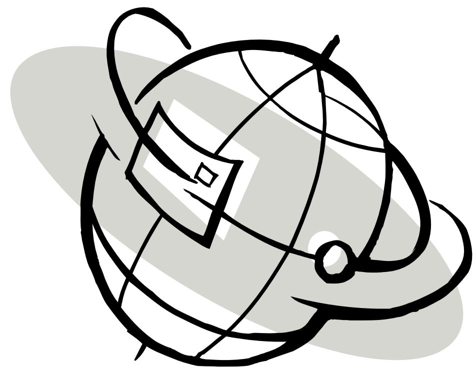
Dean, Mewbourne College of Earth and Energy and Lester A. Day Family Chair

Visit our Web site at:
http://mcee.ou.edu

I hope you enjoy the 2009 edition of the *Earth Scientist.* I believe that you will see that the Mewbourne College of Earth & Energy continues to move forward and provide a positive educational experience for our students. As always, we have experienced changes during the past year. One key change is the naming of Dr. Randy Keller as Director of the Oklahoma Geological Survey. In his dual capacity as Director of OGS and Professor of Geophysics in CPSGG, Dr. Keller is in a good position to continue the public service mission of the OGS, while expanding the research component of the Survey. We also welcome Ameil Shadid as Director of Development for the college. Ameil comes to us from the Price College of Business, and oversees a "restructured" development group within the college which includes Allison Richardson and Naila Williams. Ameil, Allison and Naila all look forward to continuing our programs, and working with all of our constituents on projects of mutual interest to support the educational mission of the college.

As you will see from the various articles, our students continue to perform in an outstanding manner, and many have received recognition for their work. Our faculty have also continued to provide strong research and teaching, and some of these activities are highlighted in the magazine.

We are also seeing the direct benefits of our program to upgrade our labs and other teaching facilities. I want to take this opportunity to again thank our alumni, industry,



and other supporters for their help in making this happen. This provides the capability for the Mewbourne College to continue our heritage of strong, "hands on" laboratory-based education, which I believe is one of the strengths of our programs. We have outstanding facilities such as our upgraded G&G labs, PE undergraduate teaching labs, MI-SWACO Fluids Lab and the Crustal Imaging Facility. In August, we will begin the installation of the Drilling Simulator provided to OU by National Oilwell Varco, and also hope to move forward with a new OU Geology Field Camp. We will also be starting the overall remodeling of the Sarkeys Tower to have improved space for our faculty, staff, and students, along with improved space for some of the facilities mentioned above.

So I am pleased to report that we are making good progress in the college. Again, I hope you enjoy the 2009 edition of the *Earth Scientist.*

Joe D. Dischinger

AAC UPDATE

Alumni Advisory Council Chair
2008/2009
ExxonMobil Production Co.

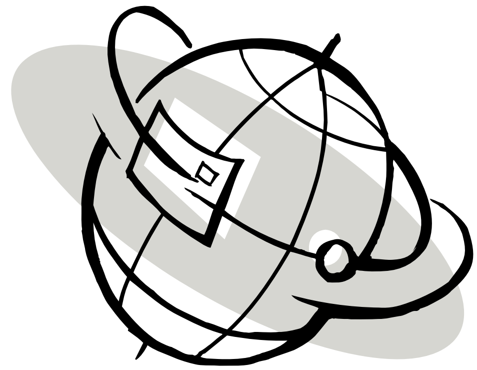
Please visit our Web site at:
www.ougeoalumni.com

Hello from the Alumni Advisory Council! It's always a pleasure to see the campus growing and prospering. Christina and I make the trip to Norman several times a year and each time is like a new snapshot of success! There are a lot of exciting developments unfolding at the ConocoPhillips School of Geology and Geophysics that I want to share with you. The progress made this year by the School under the leadership of Director Doug Elmore has been outstanding. Enrollment is up, placement of graduating students has been up and our Alumni are successful. This year was another exciting year for the Alumni Advisory Council as well!

In November 2008, we saw a number of our most dedicated alumni honored for their service by the Mewbourne College of Earth and Energy through its Inaugural Distinguished Alumni and Service Awards. Those who were honored were Denny Bartell, Dave Campbell, James Gibbs and Jon Withrow. These are names known to all of us. These men have exemplified service and dedication for decades to the college and continue to do so. Well done!

Mike Pollok, incoming President of the Alumni Advisory Council (2009-2010), is leading the effort on compiling a book of many fascinating stories gathered from Council members. The book will serve as a road map leading down the many diverse paths that our alumni have followed around the world to become successful practicing geoscientists. Whichever path you have taken (in some cases plowed), please write to Mike and share your story. I know as a student a book like this would have been a priceless gem.

Doug Elmore, Chris Cheatwood and Denny Bartell have been very industrious securing the future of fieldwork for our students. They have committed to the monumental task of building a ConocoPhillips School of Geology and Geophysics Field Camp. Doug and Chris found a perfect little corner of Colorado (not in a river floodplain) that will be the new home to our students for weeks of fieldwork. Thank you for the efforts there, and we all look forward to seeing the new camp!



We also welcomed a new Director of Development to the Mewbourne College of Earth and Energy this year, Ameil Shadid. Ameil is very excited about his position and will definitely be an outstanding addition to our College. I encourage you to work with him to continue to develop our beloved Alma Mater. Welcome, Ameil!

I would like to thank Emmitt Lockard, Chairman of the Communications subcommittee and former President of the Alumni Advisory Council (2007-2008), for all of his hard work to develop the official Web site of the Alumni of the ConocoPhillips School of Geology and Geophysics. This site is a hub of communication that will keep alumni informed of Council activities. Also, the web site will help keep track of alumni through a directory and track tenure for members. It will be a repository for documents and happenings of the Council. In the future, we hope to expand the web site and need your feedback and ideas.

It was an honor for me to serve with the mentors and role models whom I have looked up to through most of my academic and professional career. Many have become dear friends to me and my family. I am constantly amazed at the generosity **in** both time and financial support exhibited with one central aim, to keep the ConocoPhillips School of Geology and Geophysics and the Mewbourne College of Earth and Energy among the premier institutes for energy and earth sciences. It is evident that the Sooner Nation is the finest, and I am proud to be a part of it. It has been my privilege to serve as president of the Alumni Advisory Council.

Thank you, and Boomer Sooner!

Ameil Shadid

DEVELOPMENT UPDATE

Director of Development, Mewbourne College of Earth and Energy

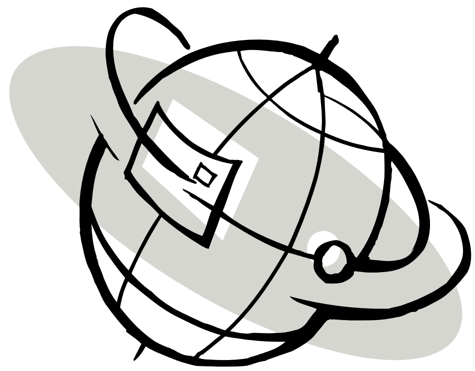
Looking for a Good Investment?

Investment, defined by Webster's Dictionary, is "the investing of money or capital in order to gain profitable returns, as interest, income, or appreciation in value."

Given the current economic environment, we are all looking for a good investment. We spend countless hours looking for an investment that has proven to provide strong returns over decades. Look no further, I have found a great investment for you. It is your alma mater, The University of Oklahoma, and we've been an excellent investment since 1890.

Please don't take my attempt at humor the wrong way. I recognize that many of our alumni and friends have suffered financially in the last year, and I am not trying to make light of that fact. However, as someone who has the opportunity every week to talk to students in our ConocoPhillips School of Geology and Geophysics, I know for certain that your investment in these dedicated, bright, and talented students will be a wise one. These students will help to shape the future of our country and our industries.

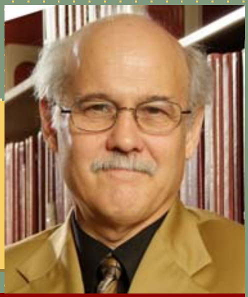
Despite all the bad news we hear about the economy, Americans are still finding a way to give to the causes they care about. According to Giving USA Foundation's 2008 Annual Report, giving topped $300 Billion in 2008; only a 2 percent drop from 2007. At the University of Oklahoma, gifts are down from last year, as well, but this fiscal year will still be the third best year for donations in OU history.



A great example of philanthropy at CPSGG are the gifts from Mr. Denny Bartell and others, that are making it possible for OU to purchase land and construct its Geology Field Camp in Cañon City, Colorado. The new camp will provide our Geology students a field experience that is critical to a well-rounded geology education, while serving as a recruiting tool for prospective students looking for a top geology program. Generations of OU students will benefit from the investment that Mr. Bartell and the other donors have made.

If you would like any information on the new Geology Field Camp or the investment in OU that fits with your philanthropic interests, please contact me, Ameil Shadid, Director of Development, at 405-325-3821 or shadid@ou.edu.

Faculty 2009



R. DOUGLAS ELMORE
Director, CPSGG
Associate Provost and Eberly Chair
Professor

Sedimentology, Diagenesis, and Paleomagnetism of Sedimentary Rocks

YOUNANE ABOUSLEIMANN
Director, PoroMechanics Institute
Larry Brummett/ONEOK Chair
Professor

Mechanics of Porous Media

JUDSON AHERN
Emeritus Professor

Geomechanics, Gravity and Magnetics, Environmental Geophysics

RICHARD CIFELLI
Associate Professor, Dept. of Zoology and School of Geology and Geophysics

Vertebrate Paleontology
Curator, Sam Noble Oklahoma Museum of Natural HIstory

MICHAEL H. ENGEL
Willard L. Miller Professor

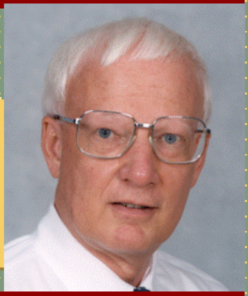
Organic Geochemistry

JAMES FORGOTSON, JR.
Kerr-McGee Centennial Professor

Petroleum Geology and Basin Analysis

M. CHARLES GILBERT
Emeritus Professor

Igneous and Metamorphic Rock Systems



CHARLES HARPER
Emeritus Professor

Paleontology

G. RANDY KELLER
Director, Oklahoma Geological Survey
Edward Lamb McCullough Chair
Professor of Geophysics

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

DAVID LONDON
Norman R. Gelphman Professor

Experimental Geochemistry, Mineralogy, Igneous and Metamorphic Petrology, Economic Geology of Metals

RICHARD LUPIA
Assistant Professor
Assistant Curator, Sam Noble
Oklahoma Museum of Natural History

Paleobotony, Palynology, and Paleoecology

ANDREW S. MADDEN
Assistant Professor

Nanogeoscience and Interfacial Biogeochemistry

MEGAN ELWOOD MADDEN
Assistant Professor

Earth and Planetary Geochemistry

KURT J. MARFURT
Frank and Henry Schultz Chair
Professor of Geophysics

Seismic Processing, Seismic Interpretation, and Reservoir Characterization

SHANKAR MITRA
Victor E. Monnett Chair, Earth Resources
Monnett Professor, Energy Resources

Structural Geology, Petroleum Geology, Fractured and Faulted Reservoirs

GEORGE MORGAN
Cooperating Faculty
Electron Microprobe Operator

Electron Microscopy and Microanalysis, Experimental Geochemistry, Igneous Petrology, Materials Science

R. PAUL PHILP
Joe and Robert Klabzuba Professor
George Lynn Cross Research Professor

Petroleum and Environmental Forensic Geochemistry

JOHN D. PIGOTT
Associate Professor

Basin Analysis and Seismic Stratigraphy

ZE'EV RECHES
Professor of Geology

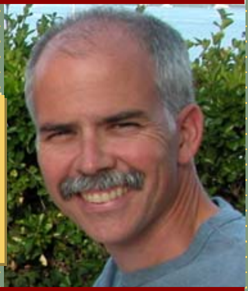
Structural Geology, Earthquakes, and Rock Mechanics

ROGER M. SLATT
Lew and Myra Ward Chair Professor
Director, Institute of Reservoir Characterization

Petroleum Geology, Reservoir Characterization, Clastic Sedimentology, and Sequence Stratigraphy

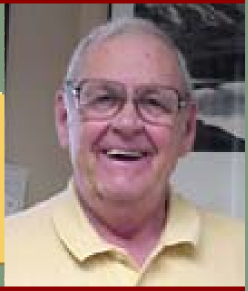
G.S. "LYNN" SOREGHAN
Brandt Professorship

Sedimentology, Stratigraphy, and Paleoclimate



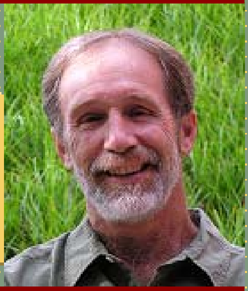
MICHAEL SOREGHAN
Assistant Professor

Sedimentology



DAVID STEARNS
Emeritus Professor

Structural Geology and Tectonophysics



NEIL SUNESON
Adjunct Professor, Geologist IV
Oklahoma Geological Survey

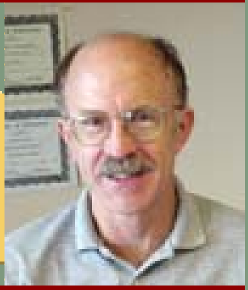
Stratigraphy, Education, Ouachita Mountains, and Guidebooks, Summer Field Camp

BARRY WEAVER
Associate Professor

Trace Element Geochemistry of Igneous and Metamorphic Rocks

STEVE WESTROP
Willard L. Miller Professorship
Curator, Sam Noble Oklahoma Museum of Natural History

Invertebrate Paleontology



ROGER A. YOUNG
Associate Professor

Geotechnical Geophysics and Exploration Geophysics

KATHLEEN KERANEN
Assistant Professor

Exploration and Crustal Seismology

Faculty / Student *articles*

Juliana Gay standing in front of the Rio Grande Rift.
(Photo courtesy of Nathan Curtain)

FUN IN THE FREMONT, MASTERING THE MORRISON

Field Camp 2009

Neil H. Suneson
Oklahoma Geological Survey

2009 OU Field Camp
Shelf Road

Back row, left to right: Brian Smith, Beth Postelwait, Stacey Evans (TA), Jordan Myers, Jeff Cook, Andrew Thiel, Greg Alexander, Chris Althoff, Steve Wade, Grant Heard, Narmina Huseynova, Dr. Tom Stanley (OGS Faculty).

Front row, left to right: Justin Newman, Lindsay Guest, Allison Stumpf, Sarah Fadaiepour, Mike Merrell (on the ground), Ben Davis, Jennifer Scott, Alisan Templet, Dr. Neil Suneson (OGS Faculty).

Not Shown: Matthew Zechmeister (TA), Dr. Randy Keller (OU/OGS Faculty).

This article is being started on Thursday, June 25, 2009, in the cinder-block building that serves as our office at OSU's field camp near Cañon City. Tomorrow is the last date of field camp, and for everyone it is bittersweet. There is no doubt in any of the faculty's minds that this was one of the best groups of geology students in recent memory. And there is no doubt that many of the students from the 14 universities that attended this year's field camp made lasting friendships.

For the first time since OU started attending OSU's camp in 2006, OU students outnumbered OSU students. And together, not surprisingly, the two Oklahoma state schools outnumbered the "exotics." The following universities were represented at the 2009 field camp: TCU, Texas Tech, TAMU Corpus Christi, Univ. of Tulsa, Univ. of Missouri Kansas City, UT Permian Basin, Tarleton State, Arkansas State, Middle Tennessee State, Morehead State (Kentucky), SUNY Oswego, and SUNY Binghamton. The large number of schools and the diversity of students and their backgrounds is one of the reasons I believe this field camp is so good for our students.

This year's OU students included *(see above photo):*

- Chris Althoff
- Sarah "Cartwheel" Fadaiepour
- Ben Davis
- Justin Newman
- Allison "You're-Too-Close-To-The-Edge" Stumpf
- Lindsay Guest
- Greg "Plant Man" Alexander
- Grant Heard
- Mike Merrell
- Steve Wade
- Jennifer Scott
- Narmina Huseynova
- Alisan Templet
- Andrew "Always-A-Goat" aka "Spider Man" Thiel
- Beth Postelwait
- Jordan Myers
- Brian Smith

Figure 2. OU students on ascent of North Twin. From left to right: Beth (standing, taking detailed notes), Jennifer (studying grass), Brian (in back), Jordan (chewing fingernails), Justin (studying same grass as Jennifer), Mike (scratching shoulder), and Ben (drinking from a camelpack).

Figure 3. Alisan and Chris at Blue Ridge. Rather than carry their colored pencils using traditional methods (pockets), these two have discovered a better way.

Figure 4. Mike (standing), Chris (OU hat), and Sarah (up-dip) at Red Canyon Park. The strike and dip of this Fountain Formation (Pennsylvanian) outcrop are well-documented, thanks to this year's students and those from past years.

The faculty was the same as last year (another good aspect of camp – stability). Jim Puckette (Director, OSU), Tom Stanley (OGS), George Bolling (Univ. Colorado, Colorado Springs), and I were assisted by TAs Stacey Evans (OU), Matthew ("The Geophysicist" aka "What-Are-You-Still-Doing-Here?") Zechmeister (OU), and Morgan Unrast (OSU), while Tim Sickbert (OSU) acted as our IT pro and general handyman. Camp cooks Michelle Leach (back for her fifth year) and Jan VanPelt kept us alive and exceedingly well fed. For one week (the field geophysics week, of course) it seemed like there were more faculty, TAs, and assorted assistants than there were students. Randy Keller (OU and OGS) was in charge of a mob almost too numerous to list individually, but I'll try – Rika Burr, Jonathan Green, Christine Worthington, Julie Chang, Jefferson Chang, and Steve Holloway.

And like the faculty, the curriculum was much the same as last year and included some projects that probably date back to the 1950s – field camp alums will no doubt fondly remember mapping at Grape Creek, the Mixing Bowl, and Twin Mountain **(Fig. 2).** Other projects included mapping metamorphic rocks and pegmatites at Blue Ridge **(Fig. 3),** measuring sections of the Jurassic Ralston Creek Formation throughout the Cañon City area, and sketching an outcrop along Phantom Canyon Road.

We went on four field trips this year – one to Pikes Peak and Florissant fossil beds, one to the CCV gold mine at Cripple Creek via Shelf Road (always a favorite) and including the old Mollie Kathleen Mine, one to the Leadville District, and one to Florence and Colorado Springs, which was a new one this year that replaced the KT Boundary trip which few of last year's students liked. We examined and compared the stratigraphy of the Raton and Denver Basins, which records the withdrawal of the Cretaceous Interior Seaway (goodbye Pierre Shale, hello Trinidad/Fox Hills Sandstone) and the uplift of the Laramide Rocky Mountains (Poison Canyon Fm./Dawson Arkose).

What do we do at field camp? We do field work, of course, such as making geologic maps **(Fig. 4)** and cross sections and measuring sections, but we also emphasize developing certain geologic skills that will be important in the students' professional careers. These skills include being able to see geology in three dimensions, understanding the difference between observations (data) and interpretations, honoring one's data, and working in teams. Although difficult to do, particularly when the camp's students come from such different academic backgrounds and have such different skill levels, we feel that working and communicating with colleagues as part of a team is particularly important.

And what memorable events set this year apart? The most unfortunate was Chris breaking his leg in the Mixing Bowl. In a way, however, the incident brought many students together in their efforts to make him more comfortable while he laid, unmoving, on a rocky slope waiting for the Cañon City EMTs to arrive. The faculty were extremely proud of how the students dealt with the emergency, including helping get Chris out of the Bowl and to the emergency vehicle. The second most memorable event has to have been Sarah's cartwheel across the "tearpants" Fremont Dolomite at Twin Mountain. Sam Bradford (remember his cartwheel at the OSU game?) would have been proud. Any reasonable person would have broken a bone or, at best, gotten all scraped up, but Sarah bounced back laughing. This year was also unusual because of all the rain we had the first two weeks (mud everywhere!), the unusually cool temperatures (rarely over 90^{o}) **(Fig. 5),** the rattlesnakes (Jennifer's at Grape Creek), and gnats (super-abundant). Typical of this year's students was their desire to get going despite the sometimes less-than-ideal (read: adverse) conditions.

Some traditions persist. Membership in "Enemies of the Morrison" continues to grow. Snowball fights on Pikes Peak **(Fig. 6)** remain popular. (This year our ascent to the summit was delayed while they plowed the parking lot.) Burgers, brats, and dogs cookouts add a certain variety to the menu and not only because certain dining-hall restrictions do not apply. And someone is always quick to point out that the line of cross section on the map templates does not match that on the cross section itself (2 mm off – right Andrew?).

We had some visitors join us at camp. Justin's wife, Amy, spent several days with us and Sarah's fiancé, Vahid Farzaneh, visited. But no OU field camp alums stopped by. Remember that you're always invited and we always have a mattress, bunk bed, and cabin space for you.

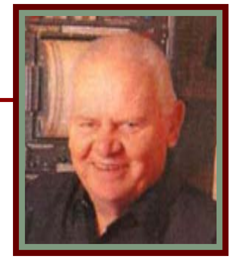
I finish this missive on the 26^{th} as the students below me complete their 3-hour field mapping exam. (Added later – the afternoon group's exam was cut short by a howling rainstorm.) For me and I think for most of the students (OU, OSU, and the exotics), it was a great field camp. To all of the 2009 field camp alums, I wish you the very best in your future studies and professional careers.

Figure 5. Sarah, Lindsay, and Beth relaxing after a hard day measuring the section at Grape Creek. Yes, it was cold!

Figure 6. Some of the OU contingent at the summit. On left, back to front, left to right: Dr. Neil Suneson, Steve Wade, Greg Alexander, Beth Postelwait, Chris Althoff, Mike Merrell, Lindsay Guest, Grant Heard, and Ben Davis. On right, back to front, left to right: Stacey Evans (TA), Sarah Fadaiepour, Narmina Huseynova, Andrew Thiel, Jennifer Scott, and Alisan Templet.

JIM LAWSON

Tribute written by ***Connie Smith****, OGS Information Officer/Web Manager; photos compliments of OGS.*



In Loving Memory

For more information about Jim, go to http://www.ogs.ou.edu/JimLawson.php

Randy Keller, OGS Director; Larry Grillot, MCEE Dean; and Jim Lawson, OGS Chief Geophysicist stop to pose by the road signs leading to the OGS Observatory. (Dog is an innocent bystander.)

From 1971 until his death in an automobile accident on August 3, 2008, James E. Lawson, Oklahoma Geological Survey Chief Geophysicist, lived on a small mountain south of Tulsa and recorded and interpreted earthquake data from Oklahoma and around the world. From the OGS observatory in Leonard, Oklahoma, he collected the readings from an array of seismometers around Oklahoma, located the events and estimated their size, then spent time talking about the shaking to the OGS main office, the USGS, countless television and radio stations, newspapers and concerned citizens who called when a quake was felt.

Jim lived on the OGS grounds about 350 yards away from the building housing the seismic monitoring equipment. He ran computers, built a web page, fixed whatever went wrong with whatever was available, and did extraordinary work with what he had. His dedication to science and people was remarkable. He often worked late into the night and was always on the trail of something new to learn.

During the 1990s, the Observatory was selected as a site where Russian scientists would come to monitor nuclear testing as part of a treaty signed between Russia and the U.S. Jim was dedicated to this chance to help foster better relations between the countries and worked diligently to understand the complex treaty terms, oversee the building of the Russian facilities, and as a host, to offer the best Oklahoma has. The officials on both sides were touched and impressed with his efforts, and Jim even traveled in the U.S. to train others on some aspects of the agreement.

For nearly 20 years he spent his spare time researching rare blood factors for the Red Cross. Lawson was credited with saving a life in 1987 when he was called to a Tulsa hospital at 3 a.m. to try to cross-match a patient's rare blood type after hospital workers could not match the samples. Lawson found the answer and was credited with saving the patient's life.

On the Observatory grounds, two road signs reading "Glastnost Road" and "Observatory Lane" remain as a reminder of Jim's attempts to make the world a better place and to understand and appreciate the often unnoticed small events and earthquakes that go on all around us.

His loss was felt deeply by many who knew him as a friend and a colleague. Jim would have been surprised and very touched at the outpouring of messages received by the OGS and the words spoken at his memorial service. The magnitude of his passing, however, was no surprise to those who knew him.

Jim with the drum recorders at Leonard, OK in the late 1980's.

Okie from Muskogee New OGS Director

Professional Affiliations

AAPG

American Geophysical Union

Royal Astronomical Society (Fellow)

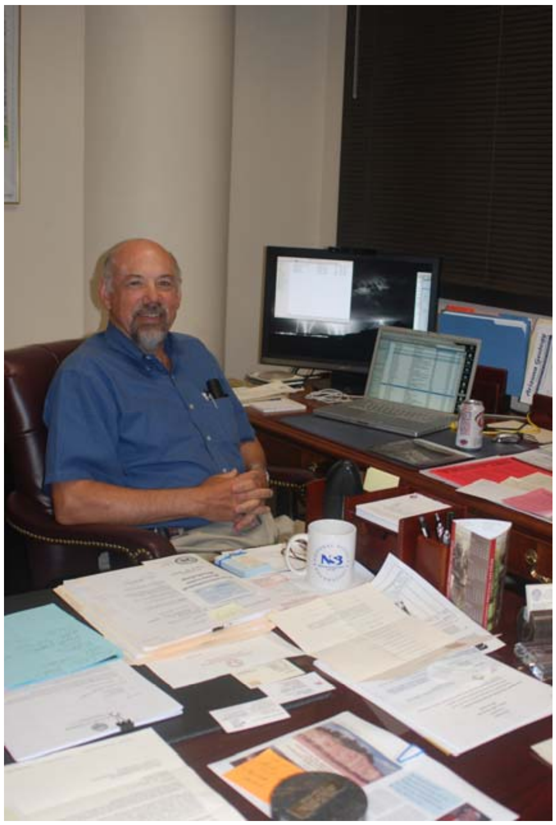
SEG

Seismological Society of America

GSA (Fellow)

American Association for the Advancement of Science

European Geoscience Union



In November of 2007, Dr. G. R. "Randy " Keller was named Interim Director of the Oklahoma Geological Survey after Dr. Charles J. Mankin retired from 40 years at the helm. At that time, it was clear to everyone that Dr. Keller was serving as Interim Director of the OGS and was there only on a temporary basis. But to the satisfaction of many people, it later became clear to Dr. Keller that he and the Survey had a lot of important work to do—together. He applied for the position and officially was named Director by the Regents on January 28, 2009. As director of the OGS, Keller is also the official State Geologist.

Dr. Keller said he began to really appreciate the OGS programs in the summer of 2008 when the staff started to compile exhibits for a retrospective of Survey programs and history for the first 100 years and make plans for the second century.

"The first months at the OGS were so busy with budget activities, publications, and getting to know the people and the projects that I really hadn't had time to stop and consider what a wide range of study goes on at the Survey," Keller said. "Survey investigations have covered a tremendous variety of issues and subjects in the first 100 years, but there is so much more on the horizon that I really became excited about the possibilities. I found that I enjoy working with the people at OGS, and appreciate the hard work they put in to make Survey projects successful."

Keller also sees great potential from the Survey's affiliation with MCEE as the number of OGS projects involving students and faculty increases.

Keller said that while the OGS will continue to focus on its strengths such as hydrocarbon studies, mapping, basic geological studies, and educational workshops, he sees great promise for the future. He thinks the OGS will be even more involved in seismic studies, water studies, and projects looking at CO_2 sequestration. "We have the data for much of this work," Keller said "and now we need to examine it, add to it and put it to use in these areas.

Archiving material and having it available to the public has been one of Dr. Keller's main interests at the OGS.

"We are working to make the cataloging of our data and core material at OPIC (the Oklahoma Petroleum Information Center) more efficient and to get more of the information available online as well," he said. "Our geologic maps from the STATEMAP program are now on the Web as soon as they are finished, and publications are being added for people to download at no charge. "Scanning material is an ongoing project, and maps and publications are added to the Web pages on a regular basis.

Dr. Keller's background in seismology turned out to be particularly important to the Survey when OGS Chief Geophysicist James E. Lawson was killed in an auto accident in August of 2008.

"Jim really did an incredible job with the equipment and facilities at the Geophysical Observatory in Leonard," Keller said. "I wish I would have had more time to work with him, but we are trying to continue his work and use the data we collect not only to observe earthquakes but to better understand them in this midcontinent setting. We have state-of-the-art equipment housed in the old Russian vault, and we will install a new borehole seismometer as well."

The Observatory's Russian vault dates back to the days of the cold war and the role the Observatory played in the 1990s in monitoring the nuclear test ban treaty and hosting teams of Russian scientists who were in Leonard to verify the tests, he notes.

Dr. Keller joined the CPSGG in July of 2006 after 30 years in various roles at the University of Texas at El Paso. With an international reputation and an extensive research and publishing background, he was named Professor and Edward Lamb McCollough Chair in Geophysics at OU. Keller's own research is a good fit with Survey activities because much of it has been in Oklahoma, the midcontinent, and the Ouachitas, making him very familiar with Oklahoma geology and seismicity. He will retain his position in CPSGG half-time, while running OGS the other 50%.

He is the founding editor of Geosphere, the on-line journal of GSA; is the associate editor of GEOPHYSICS, the Journal of the SEG (1982-83; 1987-); the associate editor of Geophysical Journal International (2004-); and associate editor of Studia Geophysica and Geodetica (2005 -). His extensive resume also includes many years of service as an officer of organizations, and a member of committees, councils and boards. His resume can be seen on the OGS web at http://www.ogs.ou.edu/KELLER/Kellerresume.pdf.

Having been born in Muskogee, Dr. Keller becomes the first OGS Director who was born in Oklahoma; a fitting way to begin the second one hundred years of Survey history and service.

*Article written and photos provided by **Connie Smith**, Information Officer / Web Manager for OGS.*

Keller addressing the attendees at OGS's Centennial Celebration.

2009 Freshman Field Trip

The students at the Albuquerque Volcanic Field. Standing from left to right: Dan Ambuehl, Rebecca Johnson, Dan Beach, Jesse Blumenthal, and Justin Haynes. Seated from left to right: Eric Courtney, Dauren Konyrbayev, Bagdat Toleubay, Ahmed Alawami, Matt Podell, John Leeman, Jake Abbott, Shayda Zahrai, Emily Dixon, and Lauren Gunderson.

The group at Valles Caldera, NM

Dr. Barry Weaver explains the geology of the Albuquerque Volcanic Field, NM.

Alcove House, Bandelier National Monument, NM

Dr. Doug Elmore pointing out the rocks in Cañon City, CO

On Saturday May 9, 2009, three vans left from Sarkeys Energy Center bound for Texas, New Mexico, and Colorado. Led by Dr. Barry Weaver, fifteen first year Geology and Geophysics majors experienced a week of world-class geology.

The Freshman Field Trip is run for students just starting out. In order to attend, students must be a declared Geology and Geophysics major and must have taken at least one introductory geology class, but no higher-level geology classes. The trip is designed to reinforce the concepts taught in introductory geology and to introduce new aspects of geology that students will be studying in future classes. However, learning about geology is only one aspect of the trip. Equally important is the chance to create connections with fellow students. Since these students are all at the same point in their academic career, they will have many classes together before graduating. By creating connections now, they will have a stronger support network in the future.

The trip was reintroduced last year after a two-year hiatus. The 2008 trip was small, with only seven students, but was a definite success. The students formed a very cohesive group and met regularly (both academically and socially) through the subsequent fall and spring semesters. Dr. David Stearns and Dr. Charles Gilbert, both emeritus professors in Geology who had run the trip in previous years, led the 2008 trip. However, both had agreed to return only for that year with an understanding that the trip would continue in future years under different leadership. Dr. Weaver, who was also on the 2008 trip, agreed to run the trip following their departure. Dr. Doug Elmore joined the trip for the two days spent in the Cañon City / Colorado Springs area. Rounding out the group were two graduate students, Rika Burr and Stacey Evans, and one staff member, Gail Holloway.

This year's trip concentrated primarily on New Mexico and Colorado with one stop in Texas. Geologic highlights of the trip included: Palo Duro Canyon, the Sandia Peak Tramway, the Albuquerque Volcanic Field, the Rio Grande Rift, Valles Caldera, dinosaur footprints along Skyline Drive, structures outside of Cañon City, Garden of the Gods, the Mollie Kathleen gold mine, and Spanish Peaks. Unfortunately, a planned stop at Capulin Volcano was abandoned due to severe weather. In addition to the purely geological aspects of the trip, cultural and historical stops were also included, many of which also showed wonderful geological features and concepts; some of these included Petroglyph National Monument, Old Town Albuquerque, Bandelier National Monument, and Old Town Santa Fe.

From comments received, the students not only learned a lot on the trip, but they also had a great time while doing so!

*Written by **Gail Holloway**, ConocoPhillips School of Geology and Geophysics*

Roger M. Slatt
Ward Chair Professor of Reservoir Characterization
and Director, Institute of Reservoir Characterization

Activities of the Institute of Reservoir Characterization Within the ConocoPhillips School of Geology and Geophysics: 2008—2009

The Institute of Reservoir Characterization dates back to the mid-1990's as part of the Sarkeys Energy Center integrated research program. The first Director, ***Dr. Dan O'Meara*** developed the Institute and led the completion of several integrated (geology, geophysics, petroleum engineering, petrophysics) studies and the granting of several degrees to graduate students. ***Roger Slatt*** assumed the Director's role in 2005 when he stepped down as Director of the School of Geology and Geophysics. Since that time, the Insitute has been successful in completing numerous geoscience studies, leading to the granting of 22 M.S. degrees and 3 Ph.D. degrees (Fig. 1). Thirteen students are currently working toward completion of their degrees, and several new students have been accepted for the Fall 2009 semester. The Institute has attracted a significant portion of over $3MM in research grants for collaborative reservoir characterization studies. Also, as part of the program, graduate courses taught by ***Dr. Slatt*** include Introduction to Reservoir Characterization (co-taught by ***Dr. Abousleiman***), Reservoir Characterization II (centered around the use of Petrel™ software, as provided and taught by Schlumberger's ***Eva Peza*** and ***Bob Davis***), Petroleum Geology of Deepwater Depositional Systems, and Research Seminar. Related courses in geophysics, geomechanics, geochemistry, and engineering are taught by other faculty within the College of Earth and Energy. The research program has three focus areas in order to offer both stability (the three-legged stool concept!!) and variety to students. These components are: ***Unconventional Gas Shales/Tight Gas Sands***, ***Petroleum Geology of Deepwater Depositional Systems***, and ***Sequence Stratigraphy Applied to Reservoir Characterization***. Student activities within these focus areas are summarized below.

Unconventional gas shales/Tight gas sandstones

Much of the our research program in gas shales has been funded to date by Devon Energy Co. Additional research into pore-scale and geomechanical properties of gas shales is being conducted within the Institute. From this research by several students, a systematic characterization workflow has been developed which incorporates litho- and sequence-stratigraphy, geochemisty, petrophysics, geomechanics, and advanced seismic analysis. The workflow encompasses a variety of analytical techniques at a variety of geologic scales. It is designed as a means to identify the potentially best reservoir, source, and seal facies for targeted horizontal drilling.

At the pore and rock sample scales, scanning electron microscopy (SEM) and high resolution scanning electron microscopy (FE-SEM) have provided insight into the potential storage of gas, gas migration pathways, and geomechanical rock properties important to drilling. M.S student ***Steven Arroyo*** is developing a technique for quantifying the composition and porosity of shales using FE-SEM in conjunction with ***Dr. Neal***

Figure 1

O'Brien at The State University of Potsdam, in New York and Clarkson University, also in New York. This follows upon the Ph.D. research completed this year by ***Prerna Singh,*** who identified lithofacies in the Barnett Shale, and their stacking pattern into progradational, retrogradational, and aggradational parasequences. This dissertation led to development of a high frequency sequence stratigraphy for the Barnett Shale; of more general application to other gas shales is the workflow she developed for high resolution sequence stratigraphic analysis of unconventional gas shales.

Geomechanical properties vary among shale lithofacies in the Barnett and Woodford shales due to variations in their mineral composition and crystal structure, and bedding/laminae planes. M.S. candidate ***Rafael Sierra*** is currently working with ***Dr. Younane Abousleiman*** to isolate the effects of these different factors on shale fracturing and wellbore stability. In a larger- scale study of geomechanical properties of shales, ***Romina Portas*** recently completed an M.S. degree characterizing and quantifying fracture patterns in a Woodford Shale quarry using a combination of field mapping, core and borehole image log analysis (from a well drilled behind the quarry by M.S. candidate ***Nichole Buckner***), as well as both a LiDAR and 2D seismic survey (Fig. 2). Romina's work has added to understanding of reservoir-scale fracture patterns in the Woodford. Ph.D. student (in Petroleum Engineering) ***Minh Tran*** characterized the fracture properties of this same core for his M.S. degree under the direction of ***Dr. Abousleiman***.

Cooperative geochemical research with ***Dr. Paul Philp*** and his students has demonstrated that geochemical data, including Rock-Eval, Total Organic Carbon (TOC) and biomarkers, can be linked with sequence stratigraphy, and in some cases, can be used to predict temporal variations in anoxic-oxic depositional environments resulting from sea level fluctuations. Organic matter is preserved under anoxic burial conditions, leading to enrichment of preferred potential gas source rocks within different small-scale stratigraphic intervals. This linkage has provided a means of regionally mapping preferred potential source rocks over broad areas.

In conjunction with ***Dr. Eric Eslinger*** of The University of St. Rose, New York, a methodology for quantitative well log analysis of gas shales using his commercial program GAMLS™ (taught to many OU students each year by ***Dr. Eslinger***). Ph.D. candidate ***Nabanita Gupta*** is conducting very detailed compositional analysis of gas shale paraseqeunces to relate to log response. Working with her on the issue of log analysis of gas shales are M.S. students ***Julieta Vallejo*** and ***Angel Gonzalez***. We have discovered some discrepancies in the log-rock relationships that are being investigated as part of Nabanita's research.

Because in many areas, gas shale wells are now drilled horizontally, it is difficult to develop a log-based, regional stratigraphic framework for intervals stratigraphcally beneath the wellbore. Thus, it is imperative to develop methods to seismically image and map the features mentioned above. Although seismic resolution is insufficient to image individual lithofacies, collaborative research with ***Dr. Kurt Marfurt*** has led to a recently-completed M.S. thesis by ***Roderick Perez*** who demonstrated that neural net-based seismic inversion, and subsequent 3D geocellular modeling provides the capability of mapping relatively thin parasequences (and systems tracts), and thus, indirectly mapping shales of different properties (Fig. 3). Using seismic attribute analysis, ***Elizabeth Baruch*** completed an M.S. thesis which led to a high-frequency seismic stratigraphy of a 3D seismic survey area, as well as mapping and revealing the significance of karsted unconformities which immediately underlie some gas shales (Fig. 3).

In addition to graduate students and collaborative faculty within the School of Geology and Geophysics, we have two visiting professors working in the gas shale program this year. Associate Research Fellow ***Dr. Mohamed Omar Abouelresh,*** from the Faulty of Petroleum and Mining Engineering at the Suez Canal University, is developing a high frequency sequence stratigraphy for an area south of the main Barnett Shale *core* area. ***Dr. He Wenxiang***, from the School of Geochemistry at Yangtze University, is extending the biomarker research mentioned above.

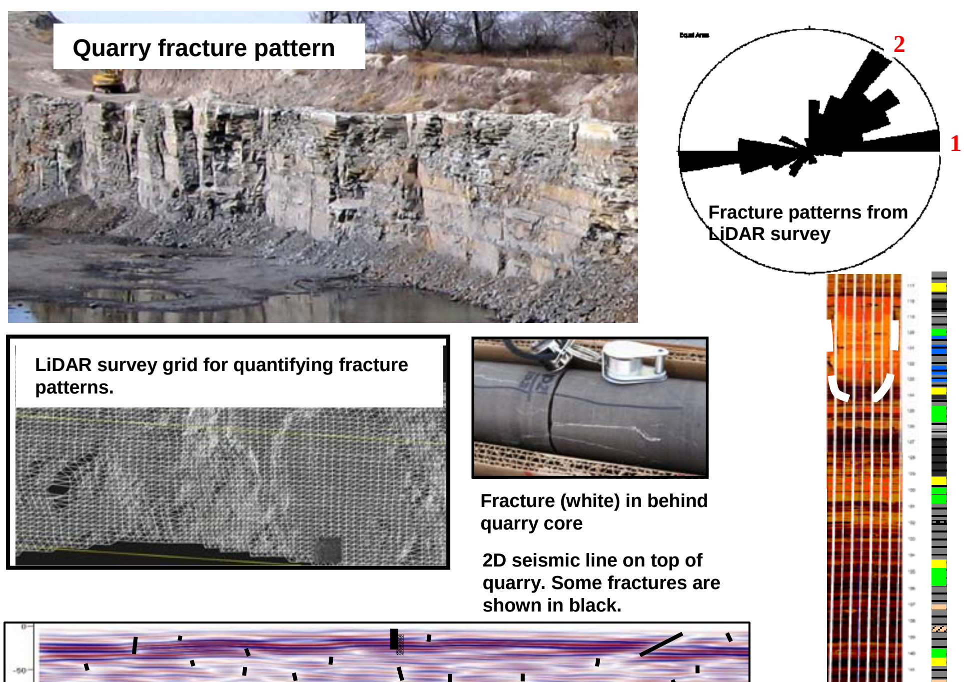
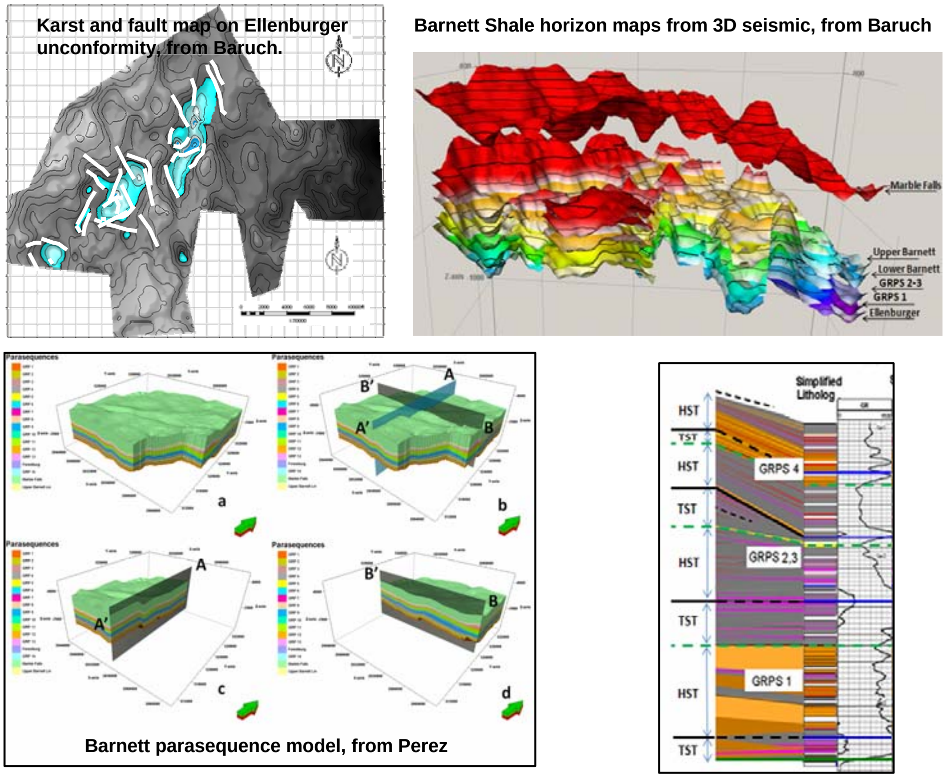


Figure 2. **Integrated measurements of fractures in a Woodford quarry, from Portas**

Borehole image log and core description (from Buckner)



Karst and fault map on Ellenburger unconformity, from Baruch.

Barnett Shale horizon maps from 3D seismic, from Baruch

Barnett parasequence model, from Perez

Figure 3. Barnett shale models, after Baruch and Perez

Barnett parasequences in 3D seismic area, from Baruch and Singh

One measure of the success of our unconventional gas shale program is that a number of graduate student applicants interested in studying gas shales applied for the program this past year, and will begin their studies this Fall. This will allow the Institute of Reservoir Characterization the opportunity to expand to other shales in other geographic areas.

In the area of tight gas sandstones, research continues in the Cretaceous Dad Sandstone (Lewis Shale member) of Wyoming. Not only is it a good tight sand gas producer in the Rocky Mountains, but the outcrops there serve as excellent analogs to global, deepwater submarine leveed-channel reservoirs. ***Carlos Santacruz*** recently completed a detailed 3D characterization of one of the leveed-channel outcrops, then performed a series of fluid flow simulations using Petrel^{TM} software (Fig. 4). He demonstrated significant effects on simulated reservoir performance of small scale heterogeneities at channel margins that are often deleted during the upscaling process. Also, ***Nabanita Gupta*** is working with ***Drs. Slatt*** and ***Abousleiman*** on the geomechanical properties of the Jackfork Group tight sands, which are gas producers from fractures in southeastern Oklahoma.

Petroleum Geology of Deepwater Depositional Systems

The deepwater petroleum geoscience educational program remains strong, with a number of students conducting a variety of thesis topics. These studies typically integrate geology and geophysics, so students work collaboratively with ***Drs. Slatt*** and ***Marfurt***, and sometimes with ***Dr. Shankar Mitra***. As a follow-up to Carlos' M.S. thesis, ***Jonathan Funk*** is quantifying the various types of deepwater channel margins from a variety of outcrops for his M.S. thesis. In May, ***Gloria Romero-Otaro*** finished her Ph.D. dissertation on the surficial geology and processes on the offshore Magdalena submarine fan system, Colombia (Fig. 5). Gloria recognized four distinct sediment distribution patterns which vary according to the local tectono-stratigraphic setting on and adjacent to the fan. Her models have significant application to deepwater exploration that is increasing in the offshore Colombia Caribbean.

In December, ***Gustavo Diaz*** completed a seismic and sequence stratigraphic analysis in the southern part of the giant Chicontepec field in Mexico for his M.S. degree. Ph.D. student ***Supratik Sarkar*** is now conducting an in-depth sequence stratigraphy/reservoir characterization study of the northern Chicontepec field, which offers a number of different challenges than in the southern field area. Supratik will also be cataloging and quantifying the seismic attributes of different deepwater architectural elements. ***Sunday Amoyedo*** returned this summer from a trip to Scotland where he acquired data to begin a Ph.D. dissertation on the Forties Field in the North Sea; the goal is to apply seismic attributes and other techniques for quantification of reservoir parameters, including geomechanical properties. M.S. student ***Diana Parada*** is finishing her thesis on the 3D seismic stratigraphy and geomorphology of Tertiary strata in the Gulf of Mexico.

Sequence stratigraphy applied to reservoir characterization

Over the past few years, we have been applying high frequency sequence stratigraphy to reservoir characterization in a number of geologic settings, mainly in the U.S. mid-continent. These studies are usually supported by local independent operators. ***Faiz Ali, John Hull***, and ***Juan Guzman*** are all being supported by Indian Exploration Co. Faiz and John have completed M.S. theses on the Red Fork and Boatwright sandstones, respectively, and Juan is finishing his M.S. on the Red Fork; all have applied sequence stratigraphic techniques to better understand these hydrocarbon-productive formations in Oklahoma (Fig. 6). M.S. student ***Dwain Veach***, of Chapparel Energy is using a similar methodology to extend exploration in the mature Burbank Sandstone of Oklahoma. ***Levi Pack*** is being supported by Ward Petroleum to complete an M.S. study on the causes of variable production in the Jackfork

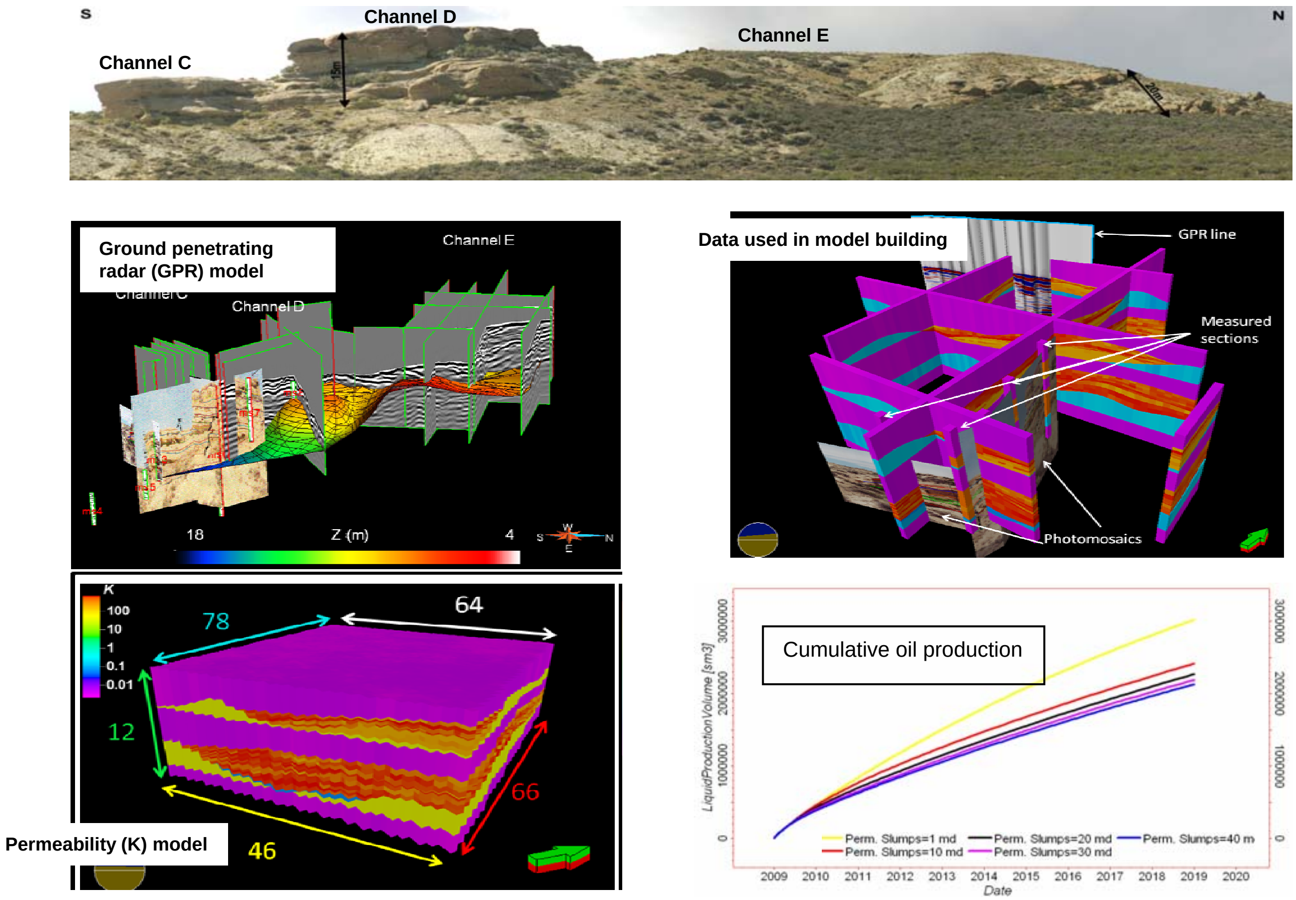


Figure 4. From outcrop to simulated well performance, from Santacruz

Formation in part of eastern Oklahoma. ***Nathan Clees*** is being supported by Mewbourne Petroleum to develop a sequence stratigraphic framework of the Skinner Sandstone in part of Oklahoma. ***Byron Solarte*** is completing a M.S. thesis on the production characteristics of Hunton Group carbonates using some very innovative tools and techniques provided by Pathfinder Energy Co. ***Austin Heape*** is conducting a study of the Oil Creek Sand in southern Oklahoma. Last, but certainly by no means least, are a Ph.D. dissertation and M.S. thesis completed this year by ***Efrain Mendez*** and ***Natalia Leon-Diaz***, respectively on the seismic and sequence stratigraphy of shallow marine sandstones in onshore western Mexico. These studies were of particular importance because of the objective of finding new gas resources in Tertiary strata as part of a larger program by the Mexican petroleum company Pemex to improve reserves. Efrain developed a seismic processing-interpretation workflow to improve upon the available seismic reflection data that traditionally has been acquired for deeper objectives. Natalia provided a comprehensive geological workflow which integrated the seismic data with well log and biostratigraphy, which resulted in the identification of new Tertiary gas targets in the area (Fig. 7). As the topping to Natalia's work, as soon as she completed her thesis, she married ***Carlos (Tex) Bahamon*** who had earlier completed an M.S. thesis in the same area!!!!

Other activities of the Institute

Activities of the Institute are not solely confined to the OU campus. Short courses on *Deepwater Petroleum Geology*, *Reservoir Characterization*, and *Clastic Sequence Stratigraphy* are taught globally to national oil companies and international geoscience (and occasionally engineering) organizations. In particular, ***Dr. Yoana Walschap***, Director of the Energy Institute of the Americas, organizes courses in South America, and actively recruits wonderful South American students for undergraduate and graduate studies within the College of Earth and Energy. Also, preparation for the annual AAPG Imperial Barrel competition is centered within the Institute. In 2007 (the first year of the global competition among university geoscience departments), the OU team won third place; in 2008 the team took the global championship among 34 competing universities by preparing a winning portfolio of exploration prospects in Australia, and in 2009 the OU team placed second in the mid-continent regional competition. Finally, Institute students and faculty are major contributors to the annual AAPG-SEG Spring Break Student Expo, which now attracts about 30 petroleum companies and 200 students from around the U.S. each year to match recruiters with students seeking careers in the oil and gas industry.

Depth is 13,272 feet. Fine grained sandstone with angular erosional contact with dark gray shale.

Depth is 13,277-284 feet. Several coarsening upward sequences (red arrows), with extensive bioturbation.

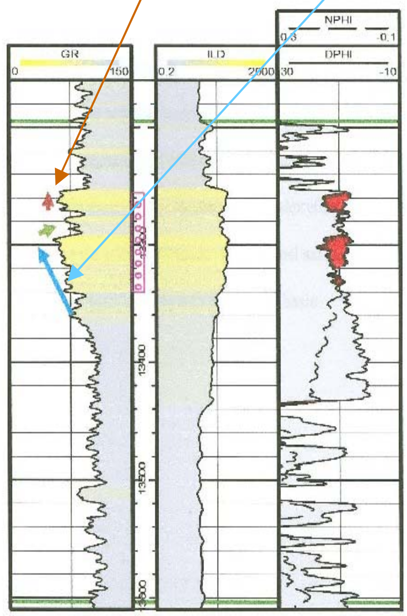


Figure 4.4-Lower Red Fork sandstone interval with depositional packages denoted by different arrows. The base and top of the Lower Red Fork sandstone interval is highlighted by green markers on top and bottom of the figure. On the left of the figure is the gamma ray log followed by the deep induction log. On the right is the compensated density neutron log. The blue arrow denotes shoreface bar sands. Green arrow highlights a subtle transgressive shale. The red arrow shows the incised channel sandstone.

Figure 6. Sequence stratigraphy of the Lower Red Fork sandstone, from Ali.

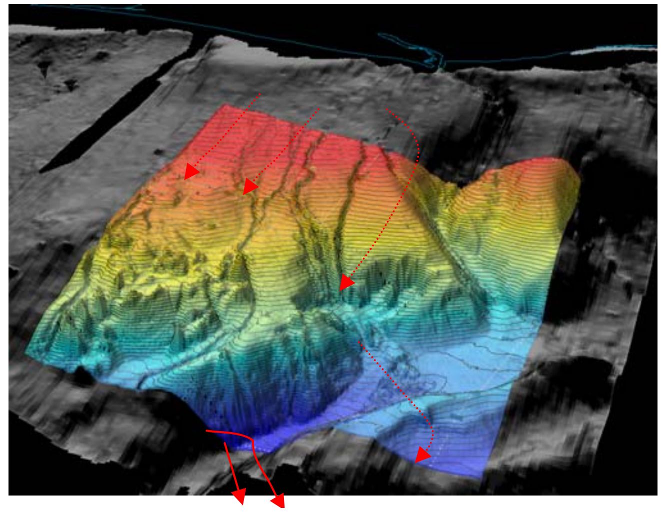


Figure 5. Modern seafloor topography on and near the Magdalena submarine fan; after Romero-Otero

The overall goal of the Institute is to promote the science of reservoir characterization through applied research and practical education both within and outside OU. The new group of enthusiastic students coming into the program in the Fall of 2009 offers promise for continued growth and increased recognition of the quality of the educational experience in the three focus areas.

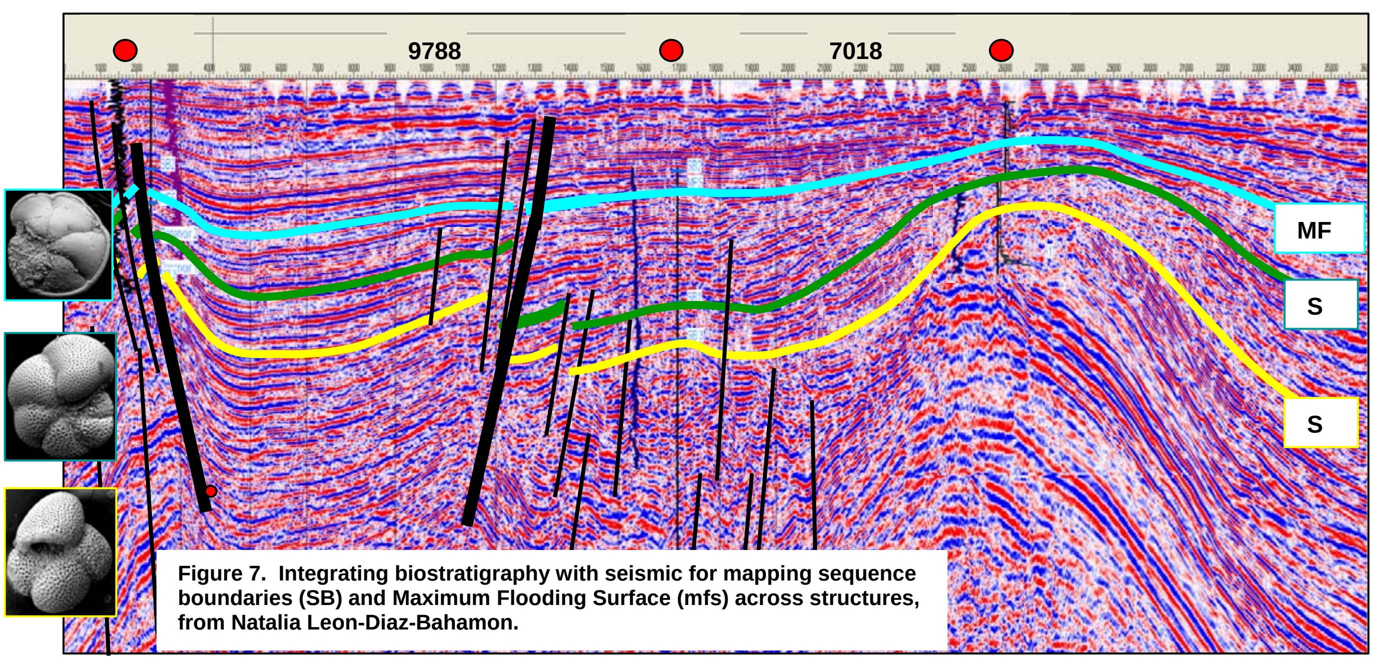


Figure 7. Integrating biostratigraphy with seismic for mapping sequence boundaries (SB) and Maximum Flooding Surface (mfs) across structures, from Natalia Leon-Diaz-Bahamon.

G. Randy Keller
Catherine Cox
Stephen Holloway
Maxwell Okure

OU Geophysics Group Leads A Massive Seismic Experiment in Oregon

For more information visit: http://www.dtm.ciw.edu/research/HLP

The multidisciplinary NSF-funded High Lava Plains (HLP) Project features complementary broadband and refraction/wide angle reflection seismic experiments is designed to study one of the youngest and most accessible, yet least understood, examples worldwide of voluminous and regionally extensive intra-continental magmatism. By synthesizing multi-level seismic images with results from geology, geochemistry, geochronology and petrology, the aim of this project is to better understand the relative roles of lithospheric structure, tectonics, flat-slab subduction, slab roll-back, slab migration, and plumes as instigators of aerially extensive magmatism that extends from the Cascades into stable North America. The combined seismic effort is the largest academic portable seismic experiment ever undertaken.


Max Okure watching drilling

After months of careful planning by the OU group and collaborator Dr. Steven Harder, the refraction/wide angle reflection part of the project began in earnest during several weeks of scouting, final permitting, and drilling in August of 2008. This effort included major involvement of OU geophysics students Catherine Cox and Maxwell Okure who are working on the resulting data as part of their graduate research. In September, this effort was followed by assembling an army of 67 scientists, students, and volunteers to deploy 2612 Texan short-period seismic recorders and 120 RT-130 recorders from the PASSCAL and EarthScope instrument pools, and fire 15 seismic sources spaced across the High Lava Plains (HLP) of eastern Oregon and adjacent parts of Idaho and Nevada. This army of helpers included 42 students from 12 different universities, mainly the University of Oklahoma, Oregon State, Arizona State, MIT, Stanford, Miami-Ohio, University of Texas at Dallas, and Rhode Island, ably assisted by 6 staff members from the PASSCAL/EarthScope Instrument Center.


Preparing the borehole

In sharp contrast to the multi-year broadband experiment, the refraction/wide angle reflection experiment was completed in a week. In the OU driven effort, sixteen two to three person teams drove across the HLP for two days burying seismometers every 800 meters along lines that spanned from Bend, OR, to southwestern Idaho, and from John Day, OR, into northern Nevada. The seismometers remained in place for two days while the 15 borehole explosions were detonated across the area. All shots went as planned and virtually all seismometers performed flawlessly, providing data for detailed reconstruction of HLP crustal structure.


Loading a hole

Filling a hole

The instrument center

This deployment also took advantage of over 100 broadband seismometers in the existing HLP array placed during the past three years by Carnegie Institution and Arizona State University. The University of Oregon, Michigan Tech, and the U. S. Geological Survey also deployed an array in the Newberry volcano area to record earthquakes and the seismic source. Together, these efforts will provide a deep and three-dimensional image of the structure of this region. New instrumentation built by PASSCAL allowed the group to carry out 3C recording using the Texan facility to study crustal anisotropy. The seismometers were located to provide high-resolution images of the mantle and crust directly beneath the path of volcanism that dotted the High Lava Plains during the past 16 Ma. In addition to the seismic component, the overarching project, funded by the National Science Foundation's Continental Dynamics program, includes field geologists, petrologists, and geodynamicists interested in resolving the origin of the sudden massive outpouring of basalt volcanism 16 million years ago and a puzzling trend of age-progressive rhyolite domes that reaches west toward Newberry volcano, the youngest complex in the trend.

The Team

High Lava Plains Rambler (to the tune of "The Gambler")

Lyrics written by Jenda Johnson, Anita Grunder, Catherine Cox, Ashley Bromley and Chris Kincaid

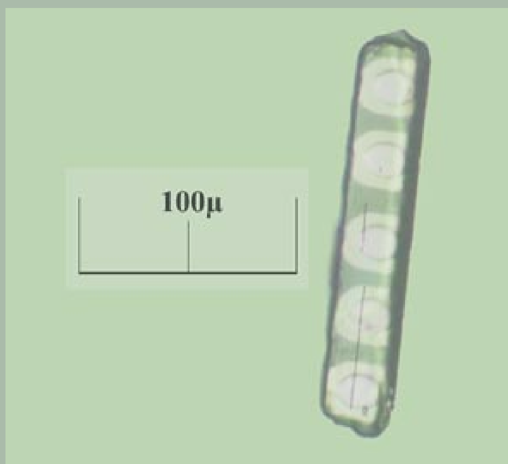
You gotta know where to drill 'em,
Know how to fill 'em,
Know how to blow them up
Know when to run......
You can't know you hit the money
'Til you jerk up all your Texans
There'll be time to tweak the data
Before the project's done.

(Who said geophysicists aren't creative??)

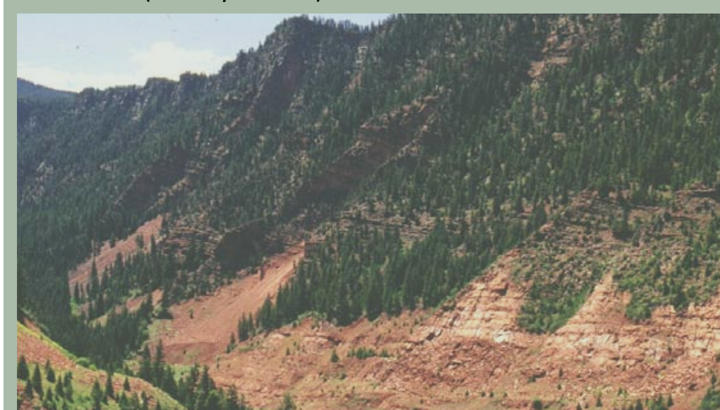
Constraining Ages of Pre-Quaternary Eolian Dust Deposits as a Means for Accessing High-Resolution Climate Archives

Lynn Soreghan[1], Michael J. Soreghan[1], Michael A. Hamilton[2], George Gehrels[3], Sohini Sur[1]

1. ConocoPhillips School of Geology and Geophysics, University of Oklahoma, Norman, OK
2. Jack Satterly Geochronology Lab, Department of Geology, University of Toronto, Canada
3. University of Arizona, Tucson, AZ



Photomicrograph of a detrital zircon from the Maroon Formation (late Paleozoic, CO). The Maroon Formation, considered to be Middle Pennsylvanian yields zircons of Permian (293 My) age, indicating it cannot be older than this age. These zircons may be contemporaneous with deposition and derived from volcanism, thus useful for directly dating the unit. The round spots are from ion microprobe analyses, conducted by Dr. Mike Hamilton (University of Toronto).



The Maroon Formation loessite of western Colorado. This unit represents the single thickest (>700m) pile of dust yet documented on Earth. The color banding visible on the mountainside is the result of paleosols intercalated with the loess.

Close-up of the Maroon loessite, showing the remarkably massive nature characteristic of a dust deposit.

Loess (terrestrial eolian silt) is abundant today, and well recognized as a high-fidelity archive of terrestrial climate change. Long neglected in the pre-Quaternary, loess(ite) is becoming increasingly well recognized in the late Paleozoic (latest Devonian through Permian). Both true 'loessite' and eolian silt deposited in a variety of continental and marine environments occur.

High-resolution dating remains a hurdle to unlocking the climate archives housed in ancient loess deposits owing to their unfossiliferous character, but detrital zircon geochronology is providing unexpected inroads. For example, the Maroon loessite of Colorado has a published age of Middle Pennsylvanian on the basis of enclosing strata; acicular detrital zircons from the base and top of a 700 m section, however, reveal a maximum age of early Permian, and apparent high rates of loess deposition. Young detrital zircons have also been recovered from the Cutler loessite of Utah. The acicular, sharply terminated morphology of these magmatic grains together with their presence in an eolian unit suggests minimal temporal storage prior to deposition. Dust within Pennsylvanian marine carbonates from the Midland basin also contain volcanic-derived grains, apparently reflecting the proximity of late Paleozoic arc volcanism.

Constraining the depositional ages of eolian dust with geochronology enables the potential for high-resolution paleoclimate studies from these deep-time datasets. For example, cm-scale analyses conducted on the Maroon and Cutler loessite units, as well as dust-infused carbonate successions document variations in multiple climate-sensitive parameters such as grain size, magnetic susceptibility, and whole-rock geochemistry that reflect changes in wind patterns and intensity as well as precipitation-evaporation. Improved age dating of these deposits enable transformation of these variations into the temporal domain, and are beginning to suggest sub-Milankovitch variations.

Article and photos provided by Producer/Host, **Devin Dennie** and Writer/Director, **Todd Kent.** ***Explorer Multimedia Inc.*** is a non-profit corporation, www.ExplorerMultimedia.org.

NEW VIDEO

Oklahoma Rocks!

www.okgeology.com

Educational earth science documentary explores the billion year history of the 46th state.

Globetrotting geologists telling tales of intercontinental adventures will undoubtedly recount imagery of ancient mountains, sparkling shorelines, vast dunes of sand, mysterious caverns, bubbling springs, precious natural resources, native peoples and of course, exotic wildlife. These world weary travelers might believe that such sights can only be seen after enduring hours, days, or even weeks of hard earned trekking to far flung places on the edges of the map.

But there is a place very close that is home to all these wonders and more, with a rich natural history that spans far beyond the inception of its formal borders. That land of natural wonders is our own state of Oklahoma, and its story is told in the independent documentary film, "Oklahoma Rocks!", a production aided in creation by ConocoPhillips School of Geology and Geophysics students and faculty.

Devon Energy geologist and CPSGG PhD candidate Devin Dennie, and documentarian Todd Kent, traveled the state exhaustively shooting for over two years to produce the independent documentary. The film seeks to explore the billion year history of the 46th state, from the Precambrian to the modern day. With a focus on earth science, the film utilizes the state's many parks, natural areas, museums and tourist attractions as a guide to turn a modern day road trip into an exciting and informative field trip.

Many Oklahoma geology topics are featured in the film. The movie begins with Precambrian era rocks in central Oklahoma but quickly moves into the Paleozoic, exploring topics such as the formation of the southern Oklahoma aulacogen and the birth and development of the Wichita and Arbuckle mountain chains. The development of ancient life and fossils is explored before the

For more information about “Oklahoma Rocks!” or to purchase the DVD, visit the Web site at **www.okgeology.com**. The movie is also available on Amazon.com.

rumbling Ouachita Mountains form and alter the landscape. The story continues on through swamps and seas with the formation of oil, natural gas and coal deposits, and then on to salty seas and red beds. From there into the Mesozoic we learn about evidence of the dinosaur age in Oklahoma, and then on into more recent times where weathering and erosion, as well as aquifers and springs, volcanics, rivers and lakes give Oklahoma its final shape and appearance. It is a breathtaking 1.4 billion year journey through Oklahoma history, compressed into a 60-minute video.

To help illustrate these complex geologic concepts, the film visits some of Oklahoma's most popular natural recreation areas. Wichita Mountains Wildlife Refuge, Alabaster Caverns State Park, Boiling Springs State Park and the Great Salt Plains National Wildlife Refuge are just of sampling of the featured locations that are well known for their connection to the state's natural history heritage. To help tell the story a variety of local experts lent their vast knowledge, including ConocoPhillips School of Geology and Geophysics's own M. Charles Gilbert, David London, Doug Elmore, and the Oklahoma Geological Survey's Ken Luza and Neil Suneson, as well as others.

Along the way, stops are made at some of the Sooner State's more offbeat roadside attractions in order to highlight their lesser known earth science connections. Munching on a "Meersbuger" (known as "the best hamburger in the state of Oklahoma) at the Meers Store and Restaurant is a good way to introduce viewers to the Meer's Fault and the concept of Oklahoma earthquakes. Unique rock outcrops are viewed amongst the zebras, rhinos and a giraffe at "Arbuckle Wilderness" and the state rock, the Barite Rose Rock, is celebrated in popular culture at the Rose Rock Festival in Noble. Several uncommon destinations like these help the film maintain a sense of exploration, adventure and fun, and introduce neophytes to the world of geology in a new and unexpected way.

The film was completed in 2008 and was well received on the film festival circuit. It was an official selection of the Southern WInds Film Festival in Shawnee, OK and the Vacant Era Film Festival in Norman, OK. At the 2009 American Federation of Mineralogical Societies Show and Convention, the film was awarded the "Excellence in Education" award.

Also in 2009, Oklahoma City-based Lance Ruffel Oil and Gas underwrote the production of an extended version of the film for educational use. Copies of <u>Oklahoma Rocks! - The Classroom Edition</u> were presented to area public school teachers by the Oklahoma City Geological Society Foundation at "Earthly Connections", an education conference held at Putnam City High School designed to help educators learn innovative ways to teach earth science in the classroom. The movie was well received and the teachers were glad to have something to help educate Oklahoma's youth about our geologic heritage.

"The goal is always to educate," said Dennie, "and making the film available to teachers through the 'Earthly Connections' event was a great first step in helping to teach kids about the earth science found in their own backyard. We hope to get this film in the hands of science teachers across the state ……..and maybe beyond."

The <u>Classroom Edition</u> has additional sequences like the "Geology Kitchen" in which Dennie (who is also the host of the documentary) uses food as a metaphor to express geologic concepts. "These segments are particularly designed to hold the interest of the students," said Kent, "and fit very well with our light hearted approach of expressing scientific ideas through various multimedia vehicles in fun, entertaining ways."

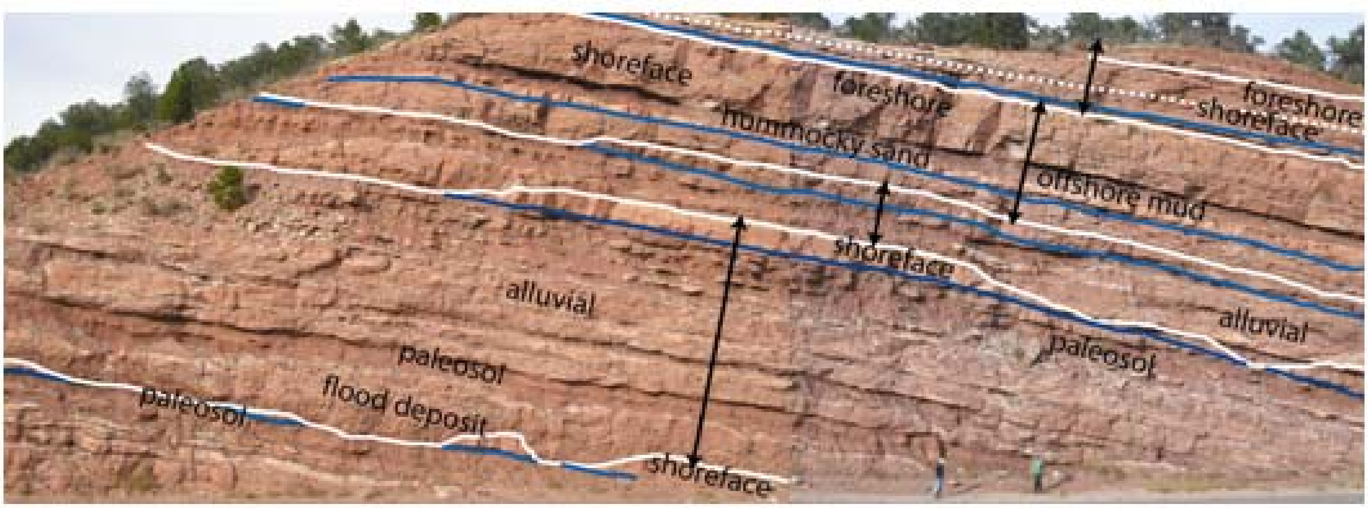
Dennie and Kent produced the film independently through their film production company Explorer Multimedia. Past projects have included the documentary "RockHounds: The Movie" and the educational travel series "North Texas Explorer."

Devin in the kitchen ……….MOVE OVER EMERIL!

Magnitude of Early Pennsylvanian (Morrowan-Atokan) Eustatic Change: Constraints from a Fan-Delta Setting

Dustin Sweet, Ph.D., Geoscientist, Chevron Energy Technology Company

The lower Fountain Formation is composed of successive continental-marine cycles. Each cycle is characterized by alluvial fan deposits overlain by a marine progradational package. A thin cobble conglomerate marks the base of marine strata and is inferred to represent a transgressive lag. Furthermore, each individual cobble bed can be traced throughout the study area. The above field relationships allow for a minimum calculation of the magnitude of sea level change because: 1) the horizontal distance of transgression can be estimated from the mapped transgressive lag deposits; and 2) the slope of the surface over which transgression progressed can be estimated through paleohydraulic analysis of the fluvial deposits. Magnitudes of sea level change over six successive cycles were calculated using an estimated depositional slope of 0.005; results suggest 10-18 m of change. A large eustatic component is inferred for these six cycles because each marine package transgresses over alluvial strata and is subsequently incised by overlying alluvial strata indicating that for each cycle sea level both rose and fell. Conversely, autocyclic components of the cycles contain alluvial facies that grade laterally into marine strata and are inferred to reflect autogenic processes. Marine strata of the lower Fountain Formation have yielded Morrowan-Atokan conodonts *(Idiognathoides sinuatus).* Few estimates of the magnitude of sea level change exist for this time period, but incised valley depths suggest 20-45 m of eustatic sea level change and modeling of ice volume and facies models suggest 40-60 m of sea level change. Our estimates are absolute minimums and the method does reflect some sensitivity to variations in slope, such that an order-of-magnitude change in slope results in ~100 m of sea level change, however slopes of this magnitude are geologically unrealistic for a depositional setting. The range given by our method approaches other estimates and indicates: 1) the Morrowan-Atokan time period experienced relatively modest eustatic sea level change compared to other times during the Pennsylvanian and may suggest lesser ice extent; and 2) this method provides a new method for estimating magnitudes of sea level change.



Marine-alluvial cycles within the lower part of the Fountain Formation at Manitou Springs, Colorado. Blue lines represent base of marine strata. White lines represent erosional surface at base of alluvial strata. Individual cycles can be traced down dip of the Late Paleozoic fan-delta depositional system and form the basis for the method of estimating magnitude of glacio-eustatic sea level variation described by Sweet and Soreghan.

2009 AIMSS Summer Institute

Oklahoma Water Cycle

heather ahtone, Research Associate, Diversity in Geosciences Project and **Gail Holloway**, Instructor/Recruiter; ConocoPhillips School of Geology and Geophysics

The **Diversity in Geosciences Project**, in the School of Geology and Geophysics, was created to develop opportunities for American Indian students to participate in geoscience education and research. This NSF funded project (Principal Investigator, Doug Elmore) integrates indigenous knowledge into the geosciences, using art and oral history as a vehicle of learning and by acknowledging the learning styles of American Indian students. Over the last three years, this project has seen evidence that this kind of cultural integration has a positive result in all areas of participation, including an increased enrollment in the geosciences. Each summer since its inception, the Diversity Project has cooperated with OU's Native American Studies Program to provide instructional leadership to the American Indian Math & Science Society's (AIMSS) Summer Institute.

Brian Harms guides students making model aquifers.

In its eleventh year, the AIMSS Summer Institute took place on the OU campus, June 14-19, 2009. This camp for sixteen 7th-12th grade students provides an intensive research experience utilizing the same integrated approach of Western and Indigenous sciences. This year's camp focused on the various geologic and hydrologic aspects of the water cycle in Oklahoma, with a case study of the Arbuckle-Simpson Aquifer. Instruction was led by Gail Holloway with coordination on topics from Jolene Faddis, Kevin Kloesel, heather ahtone, and Brian Harms. Further instructional support was provided by Vanessa Harvey and Brittany Pritchett. The materials provided an overview of the hydrologic cycle, local resources, and development of research skills.

Students examine streamtables and rock samples in preparation for field research.

The lab and library research were conducted in the Sarkeys Energy Center. Students were divided into four-member teams, each guided by a member of the instructional staff. Through the use of an instructional workbook and directed activities, the students gained skills in conducting library and field research. This included identifying library resources – books and maps – using the OU Library catalog at the Geology Library; the construction of a small-scale aquifer; testing and identification of various kinds of rock materials for their capacity to serve as an aquifer or an aquitard; identification of various types of water resources and their role within the water cycle; and testing and identification of aquifers, wells, springs and their source.

Field research at Lake Thunderbird.

Field Research was conducted at Lake Thunderbird in Norman and in the Davis-Sulpher Oklahoma area where students visited Turner Falls, Vendome Well, and the Platt National Park's local springs and tributaries. Presentations were given on: the Earth's Hydrologic Cycle; the Hydrologic Cycle in Oklahoma; Chickasaw Basketweaving and its relationship to water; Garber Sandstone; Lake Thunderbird; Cultural History of Vendome Well; History of Chickasaw National Recreation Area; Arbuckle-Simpson Aquifer, Turner Falls, Vendome Well, Antelope and Buffalo Springs; Native American art on the OU campus– what science is revealed?; and Creating Charts, Graphs, and Presenting Data Sets.

At the conclusion of the research experience, the students reported their findings through a multi-media presentation. Each team contributed to the final presentation through a combination of visual and oral information. The activities and tasks seemed well targeted at the group, as assessed from the active participation and limited assistance needed for them to complete the assignments. The AIMSS has become a key component of the pipeline intended by the Diversity Project. Through this and other outreach events, the Diversity Project has been able to successfully increase enrollment in the geosciences by Native American students. For more information about the Diversity in Geosciences Project visit the website at www.ou.ed/geodiversity.

Diversity in Geosciences Project
ConocoPhillips School of Geology and Geophysics
100 East Boyd Street, Suite 710
Norman, OK 73019-1009
(405) 325-1326 voice/Project Office
(405) 325-3253 voice/School Office
(405) 325-3140 fax

Field Research at the Arbuckle-Simpson Aquifer

Integrated Studies of Structural Systems: Fault-Related Structures, Damage Characterization, and Shallow-Seismic Analysis

Seth Busetti, Jefferson Chang, Matt Hamilton, Vincent Heesakkers, and Dr. Ze'ev Reches
ConocoPhillips School of Geology and Geophysics, University of Oklahoma

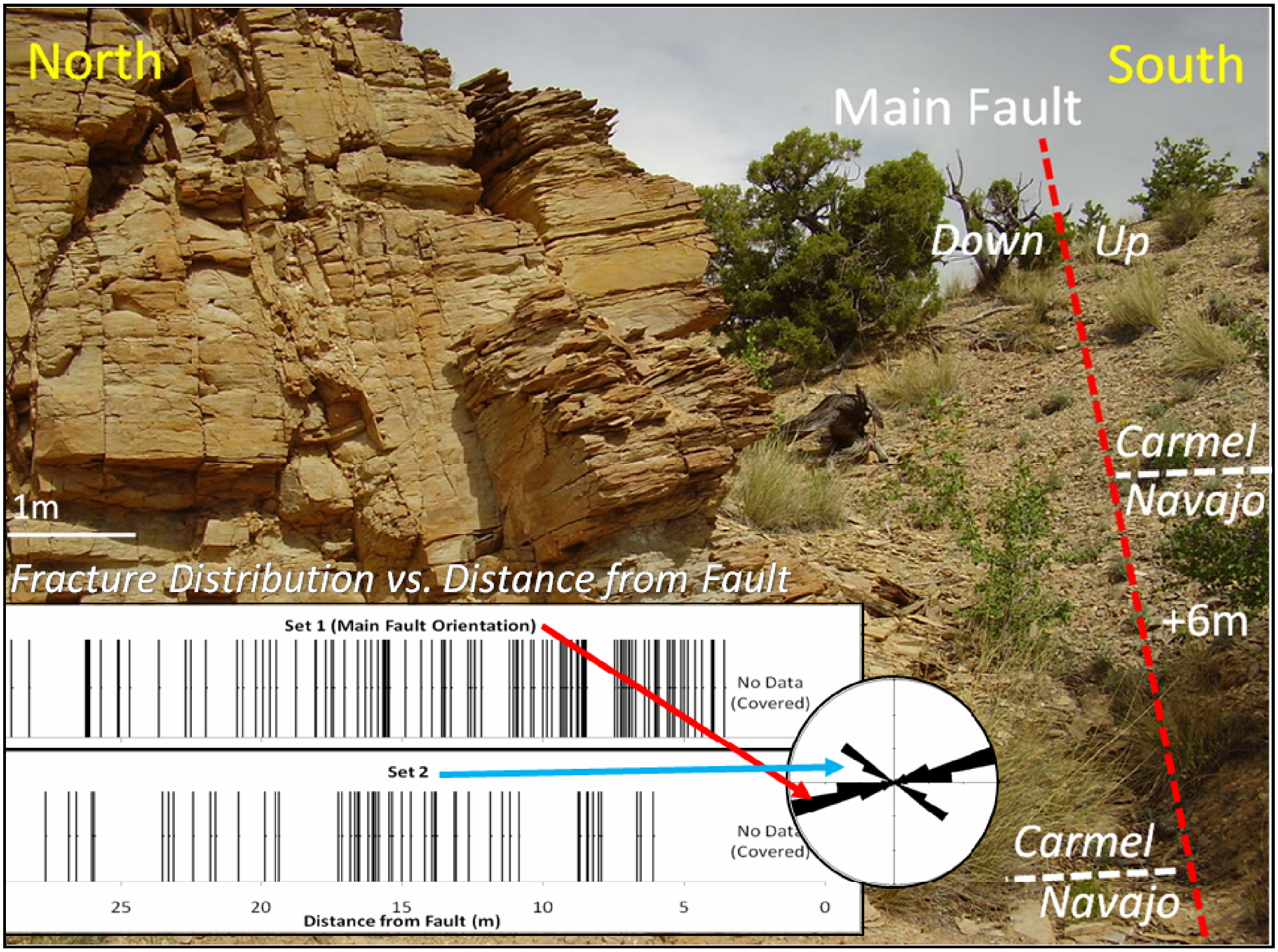


Figure 1. *A fault zone near Cedar Mountain, Utah. Interpreted fault location shown by dashed red line. Inset 1-D fracture spacing logs and rose diagram shows fracture distribution relative to the main fault.*

This June, we opted to beat the sweltering Oklahoma heat by spending 2½ weeks camping out and studying structural processes in some of our favorite field locations in Utah, Arizona, and southern California. We began near Cedar Mountain, Utah, on the eastern margin of the San Raphael Swell, an asymmetric anticline associated with Laramide uplift. In this area, previously studied by Z. Reches and S. Busetti, the limestone layers of the Carmel Formation hold the world record for fracture density (Reches, 1998) despite being far away from a major plate boundary. We ran multi-directional, shallow-seismic surveys using 24 to 48 geophone radial arrays to investigate the signature of the high fracture density on seismic velocity, and to measure velocity anisotropy due to fracture orientation. After 389 (give-or-take) consecutive swings of our controlled-source, a 16-pound sledge hammer, we wished we were back in air-conditioned SEC! We also characterized the damage zone of a small normal fault by measuring fracture intensity and orientation as a function of distance from the fault and by recording seismic velocity anisotropy **(Figure 1).** J. Chang is currently processing the seismic data.

Next, we spent a few days in Arches National Park to look at well preserved regional fracture patterns - the numerous arches are formed by erosion along long, bounding joints. The massive Entrada Sandstone displays magnificent fracture surface morphology: plumose patterns, fringes, and hackles, indicators of the tectonic conditions during regional fracturing. From Arches, we moved on to the

Henry Mountains, a classical site for Eocene laccolith emplacement. First studied by G. K. Gilbert about 150 years ago, the massive intrusions formed a series of uplifted domes flanked by monoclinal flexures. Following a brief jaunt to Meteor Crater, Arizona, to discuss the finer points of shatter cone mechanics, we continued to our next major stop: the Grand Canyon, Arizona. The monoclines in the canyon, particularly the Palisades branch, were the subject of Z. Reches' doctoral dissertation. Ze'ev graciously escorted us down (and then a few days later, up again!) the Tanner Trail on the south rim of the park **(Figure 2)**. A lot of sweat is involved, but the scenery alone is worth it! The monoclines formed during Laramide reactivation of preexisting vertical faults– the Palisades branch exhibits 250 m of vertical displacement. Because the steep faces of the canyon cut in and out of the structures, nearly completely exposed cross-sections uniquely reveal the relationship between the faulted core and the overlying folded sedimentary sequence.

Figure 2. *Group posing at Lipan Point, south rim, Grand Canyon, AZ. From left to right: Matt Hamilton, Jefferson Chang, Seth Busetti, Vincent Heesakkers, and Ze'ev Reches.*

The final leg of our journey landed us at the San Andreas Fault at Tejon Pass, southern California. This area was previously studied by OU MSc students Brent Wilson and Joni Verrett and the geophysics class of Dr. Allen Witten, and is part of the PhD research of J. Chang. The Tejon Pass fault segment is located along the major bend of the SAF and displays the rupture trace of an 1857 M=7.9 earthquake. We set out to collect data on the character of rock damage as function of distance from the fault segments. The local granite ranges from fine gouge powder near the fault **(Figure 3a)** to a pulverized zone 10s of meters away **(Figure 3b)**, and extends to mostly intact granite around 100m from the fault. Along four survey lines ranging from 30-600 m long (e.g., **Figure 3e**), we described the local geology **(Figure 3a, b)**, recorded 2D shallow-seismic **(Figure 3c)**, and used a magnetometer to measure the local variations in the magnetic field **(Figure 3d)**. Preliminary results suggest that the velocity drops non-linearly from 3400 m/s in the undamaged zones to 1700 m/s in the core of the fault zone, the latter of which is equivalent to the seismic properties of unconsolidated sediment. As compensation for nearly freezing each night at the campsite, we also discovered an unknown branch of the San Andreas Fault!

As we work through the data in the upcoming months, we plan to develop a better picture of how these structures developed. Then, if everything goes as planned, for the good of science, we'll soon be in the field again.

Figure 3. *Montage of field work on a ruptured escarpment of the 1857 Tejon Pass earthquake (M 7.9), along the San Andreas fault zone, CA. Examples of mapped, damaged fault zone material: (a) fine powder gouge and (b) pulverized granite. (c) Matt Hamilton gets ready to trigger a controlled-source experiment. (d) Ze'ev Reches and Seth Busetti take magnetometer readings along the fault zone. (e) A 92m survey line along a roadside outcrop, where Jefferson Chang (far left) records seismic data created by Matt Hamilton (right standing) and Vincent Heesakkers (seated).*

Mapping Igneous Intrusives and Extrusives from 3D Seismic in Chicontepec Basin, Mexico

Victor Pena, *Supratik Sarkar, Kurt J. Marfurt (The University of Oklahoma), and Sergio Chávez-Pérez (Instituto Mexicano del Petróleo)*

Summary

Although common in occurrence in many basins in the world, the 3D seismic expression of volcanics is somewhat under-reported in the geological and geophysical literature. Although magnetic data can often identify volcanic rocks in the sedimentary column, pole-reversal with remnant magnetization, diagenetic alteration of volcanic extrusives, and shallow basement structures can all contribute to ambiguous magnetic signatures. Fortunately, both volcanic extrusive flows and intrusive dikes and sills often have a distinct seismic signature that once seen, are often easy to recognize. In order to build such a geomorphological catalogue, we present seismic amplitude and attribute images of both intrusive and extrusive igneous rocks seen in a modern 3D survey acquired over the Chicontepec Basin, Mexico.

Introduction

Davies et al. (2004) included in their volume on 3D seismic illumination of sedimentary basins, three excellent case studies illustrating the seismic expression of volcanics in the North Sea. Recently, Garten et al. (2008) identified a volcanic vent on seismic acquired in the Norwegian Sea. In Latin America, Klarner et al. (2006) showed how 3D seismic can image not only shallow volcanics and submarine vents, but also deeper sills. Volcanics are routinely encountered in Argentina in both the Neuquen and San Jorge Basins (Juan Soldo and Daniel Delpino, personal communication). These Argentine volcanics can serve alternatively as an updip seal, as the reservoir rock (if fractured), or as a cause of fracturing above intrusive dikes due to either the force of mechanical injection or due to subsequent differential compaction about these relatively rigid features. The volcanics in Argentina also have a profound effect on permeability. In some lithologies, volcanics reduce permeability through the formation of clays; in others volcanics improve permeability through some kind of leaching process.

Given the relative paucity of published 3D seismic images of volcanics, one of the primary objectives of this work is to not only map them in the Amatitlán Survey but to quantify the negative impact they may have on seismic data quality. A future question to be addressed is whether there is any correlation between the volcanics in Amatitlán and the overall poor permeability.

The Amatitlán Survey was acquired in 2003 and is situated in the northern part of the Chicontepec Basin to the west of Tuxpan, Veracruz. The Chicontepec Basin is one of the most productive basins in Mexico. Unlike the world-famous Cantarell and Poza Rica carbonate fields, characterized by high-producing wells tapping large continuous reservoirs, the Chicontepec Play is characterized by thin, sometimes multi-storied turbidite and fan reservoirs that are incased in shales and cut by mud slumps and mass transport complexes. The sand reservoirs are relatively small and have very low permeability. Most modern wells need to be hydraulically fractured, with anomalously higher production being hypothesized as due to fractures draining nearby, otherwise disconnected sand bodies.

Impact of volcanics on the reservoir rock

The principle reservoirs in the study area consists of deep water turbidites deposited during Paleocene- Eocene time within a narrow foreland basin created during the evolution of Sierra Madre Oriental. The reservoirs have complex stratigraphy and have undergone several phases of diagenesis (Barmudez et al, 2006). A regional study on volcanic sediments in the Gulf coastal province by Hunter and Davies (1979) indicates that the majority of the volcanic activity in the Mexican Gulf coastal region took place during Miocene to recent times. Due to the timing of the volcanic activity and its discontinuous nature, it is unlikely that extrusives in Chicontepec area would act as seals. As the intrusive and extrusive bodies cross cut the potential reservoir units, those might compartmentalize the reservoir or act as a flow barrier. If hydrocarbons are already emplaced in the reservoir, the composition might be severely affected by adjacent volcanic emplacement. It may also rupture the seal rock causing depletion of the reservoir. The volcanic sediments may cause production and deposition of several pore-filling minerals and clays and may even cause welding of grains during volcanic emplacement due to the enormous heat generated and in this way might play an important role during the diagenetic process.

Although there might be several potential adverse effects on the reservoir due to the emplacement of intrusive and extrusive rocks, there is also the potential for positive effects as well. In one of the wells within the study area, it has been observed that fractures generated due to intrusion of olivine and pyroxene diabase - connected with planar lamination enhanced reservoir permeability and favored dissolution of sandstone framework and carbonate cements by fluids circulation (Bermudez et al, 2006) **(Figure 1).** So the intrusive body increased the secondary porosity and permeability and significantly enhanced the reservoir quality. So the natural fracturing associated with the volcanic emplacement is extremely important and is being studied in greater depth.

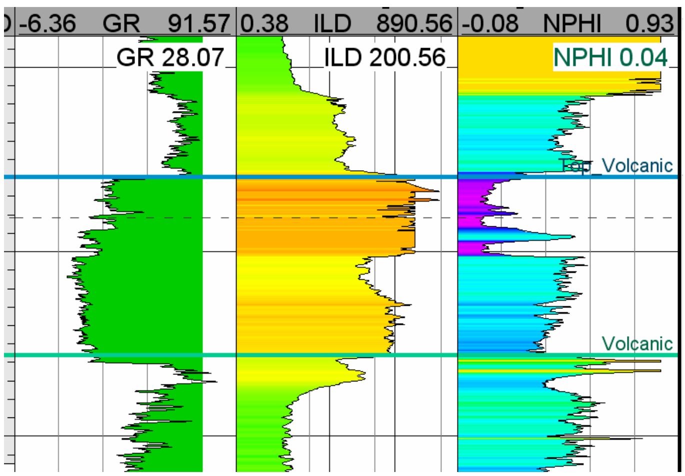


Figure 1. *As the nature of the volcanics is basaltic (Bermudez et al, 2006), the Gamma Ray values are very low, porosity is also very low, relatively better porosities might be associated with vesicular nature of basalt or natural fractures. The resistivity values are consistently very high. (Location of the well given in the following figure)*

Correlation of extrusive and intrusive igneous rocks to magnetic data

Most volcanics have a strong, distinct pattern. However, since volcanics cool slowly through the Curie point, they also acquire a strong remnant magnetization. Thus the magnetic response is the vector sum of the induced magnetization, which is a function on the inclination of Earth's magnetic field at the present time, and the remnant magnetization, which is a function of the inclination of Earth's magnetic field at the time of magmatic cooling. Grauch and Keller (2004) illustrated this effect for volcanic cones near Picuri, New Mexico **(Figure 2).** The volcanic cones indicated by the red arrows show a positive magnetic anomaly, while the one indicated by the blue arrow shows a negative magnetic anomaly. In the corresponding images over Amatitlán shown in **Figure 3**, we observe similar patterns. **Figure 3a** is a shaded relief map of the Amatitlán survey area. The topography ranges from near sea level in the east to 600 m within the survey. Arrows indicate volcanic cones and what appears to be an elongate ridge that falls within the survey. **Figure 3b** is a total magnetic intensity map that has been reduced to the pole to correct for the weak inclination at this latitude. As a processing step, the data have been upward continued to produce a long-wavelength approximation of the data, and then subtracted from the original data. This 'shallow response' image suffers from less Gibb's artifacts than if the data were high-pass filtered.

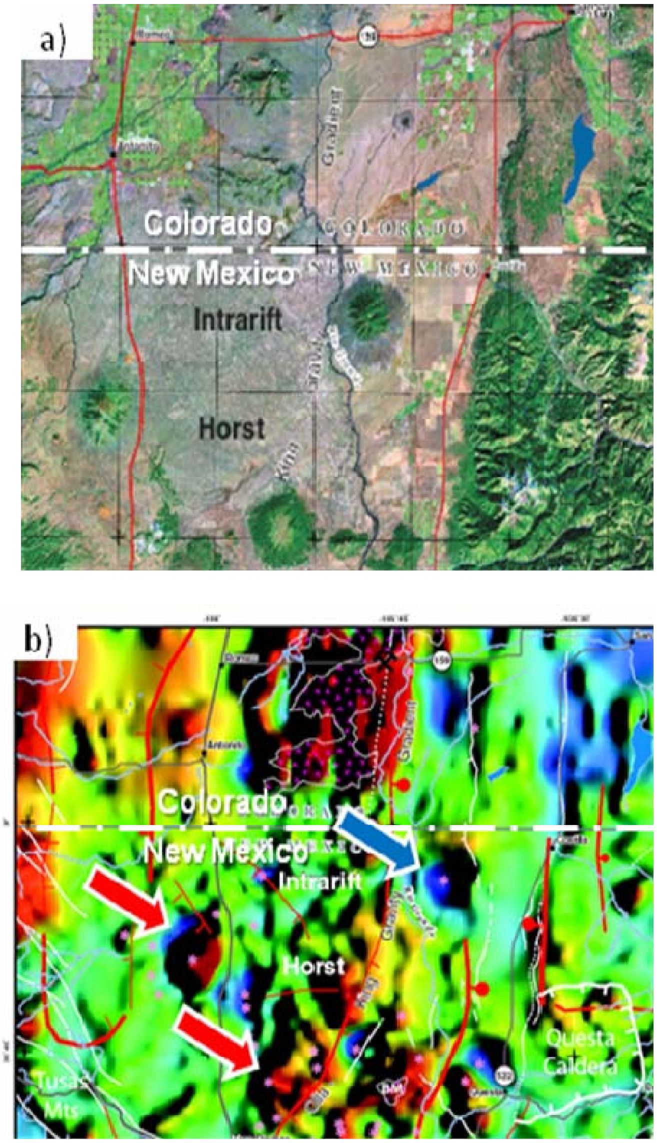


Figure 2. *(a) Thematic mapper image and **(b)** Total magnetic intensity map over the Picuri area of New Mexico, U.S.A. Red arrows indicate volcanic cones that have a positive response, while blue arrow indicates one that has a strong negative response. This negative response is due to remnant magnetization locked in during a magnetic polar reversal. (After Grauch and Keller, 2004).*

We note that two of the volcanic structures (a ridge which may be a dike, as well as a cone) have a positive magnetic response. The volcanic cone indicated by the blue arrow has a negative magnetic response, suggesting remnant magnetization aligned with a magnetic pole reversal similar to those shown in **Figure 2.** The large cones indicated by the yellow arrows do not correspond to a simple magnetic anomaly, suggesting that there are deeper sills contributing to the total response. In order to better correlate the surface topography to the total magnetic intensity we blended the two images (first converting the topography image to a gray scale) in **Figure 3c.** By blending the shaded relief topography map shown in **Figure 3a** with the coherence image we interpret other low coherence areas as being due to shallow volcanics

(Figure 4). The orange arrow indicates a low coherence area corresponding to two overlying volcanic sills, which are displayed on vertical seismic in **Figure 8.**

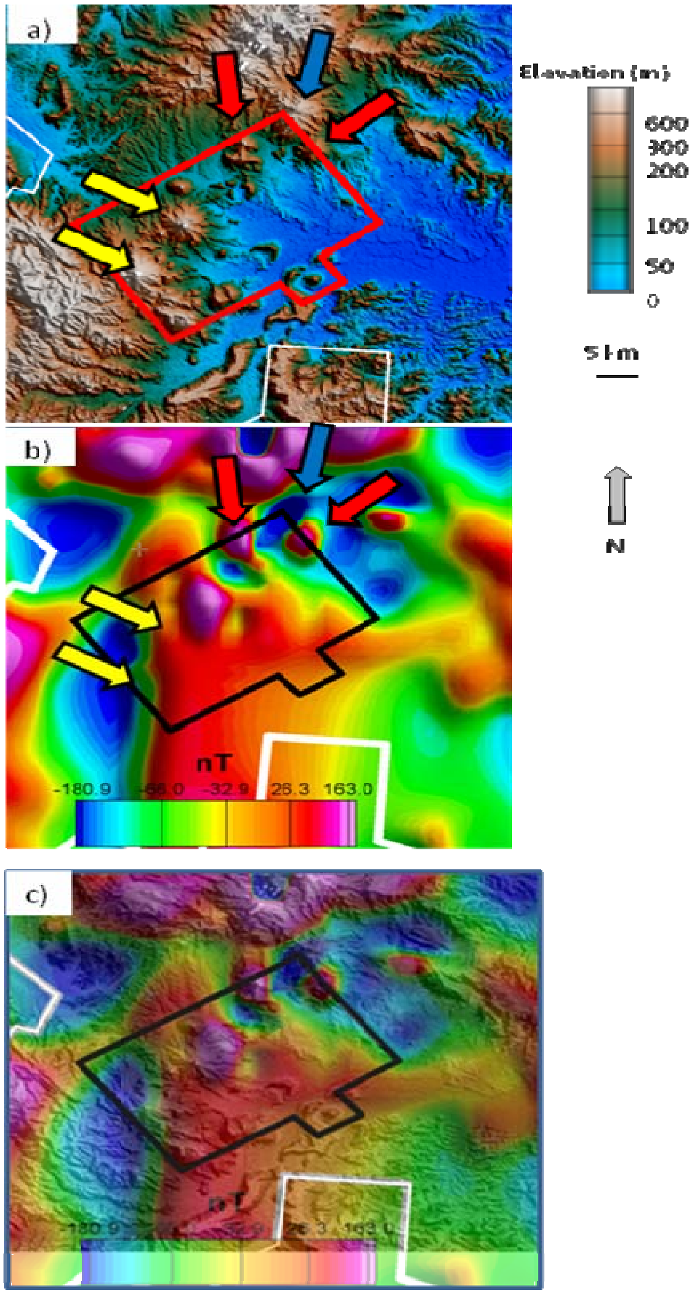


Figure 3. (a) *Topographic map with the Amatilán seismic survey outlined in red. Arrows indicate volcanoes and a possible dike. White outlines indicate limits of municipalities.* **(b)** *Total magnetic intensity (TMI) map of the same area filtered to enhance shallow magnetic anomalies (survey outlined in black). The blue arrow indicatea a negative and the red arrows positive magnetic anomalies. The signature of the volcanoes indicated by yellow arrows is more complex, suggesting buried magnetic sources.* **(c)** *Blended image of* (b) *and topography plotted against a gray scale. (Topography data from* **http://seamless.usgs.gov/website/seamless/viewer.htm**. *TMI data from* **ftp://ftpext.usgs.gov/pub/cr/co/denver/musette/pub/open-file-reports/ofr-02-0414**).

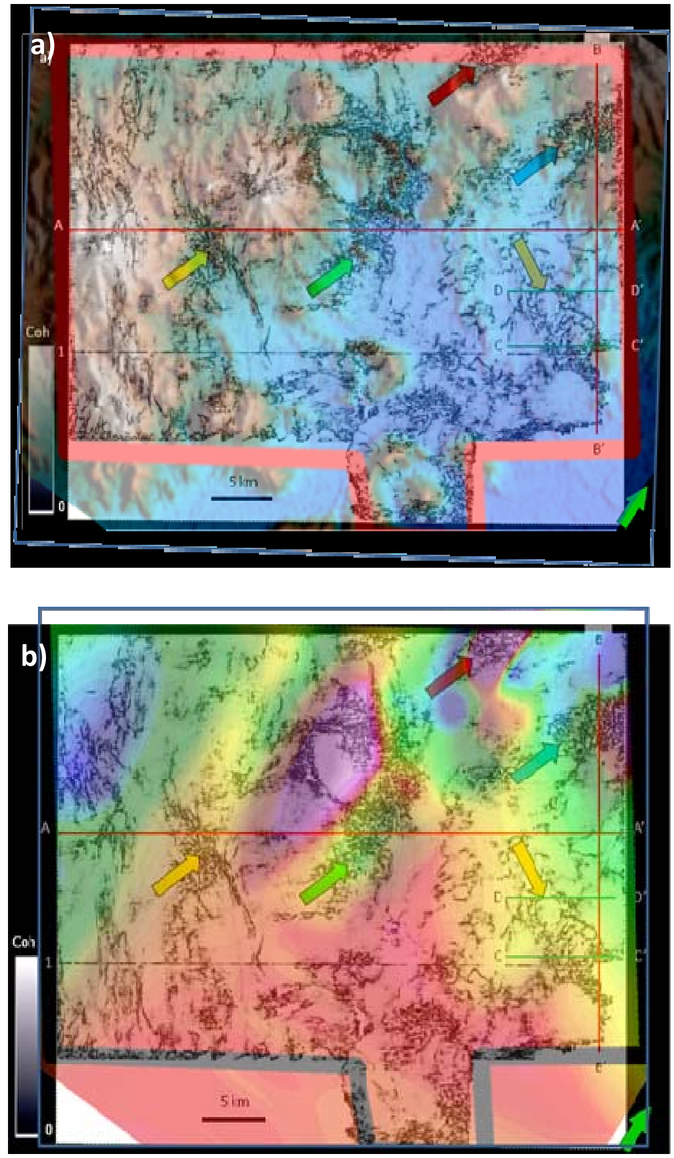


Figure 4. (a) *Coherence blended with the shaded relief topography map, and* **(b)** *Coherence attribute blended with the RTP total magnetic intensity map. We interpret the low coherence areas indicated by the yellow, green, and cyan arrows to be due to shallow lava flows associated with the volcanic cones seen in* ***Figure 3.***

Figure 5 shows the shaded relief for what we interpreted as intrusive and extrusive volcanics. We note in **Figure 5a** that the extrusive volcanics correlate well with the volcanoes seen on the topographic map, but shifted in position. **Figure 5b** shows a 3D view for one of the intrusive volcanics surface. Finally, in **Figure 6,** we display a time-structure map of the larger igneous sills seen in the survey. By blending this map with the coherence image at t=1.335 s we see a direct correlation between the location of some of the igneous sills and the seismic data quality (incoherent zones) deeper in the section.

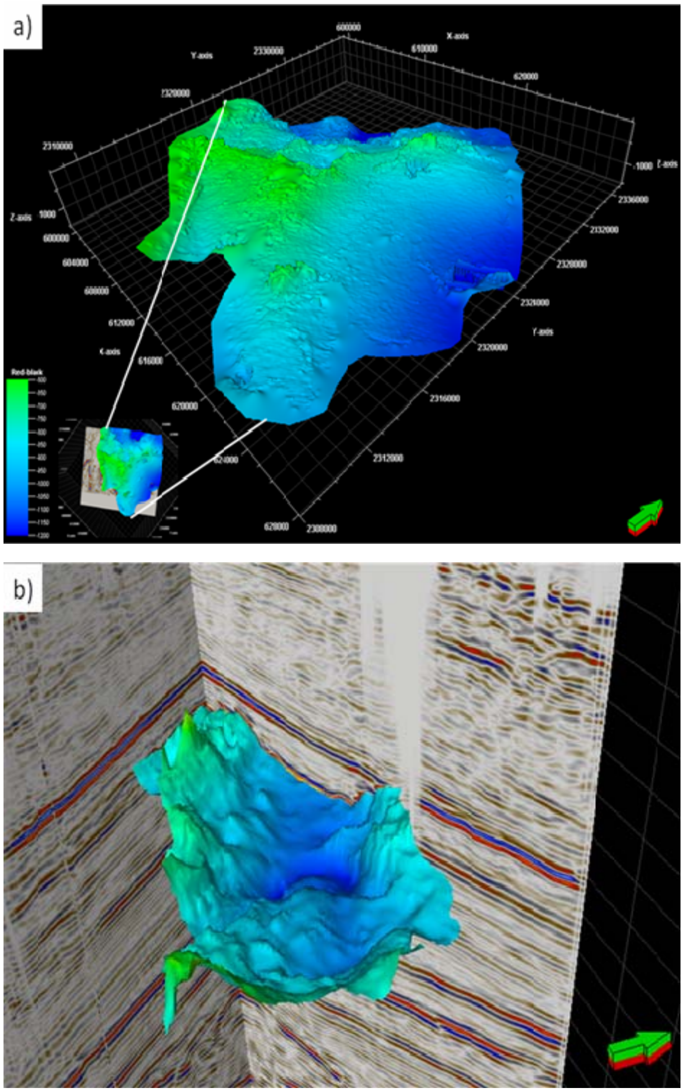


Figure 5. a) *Shaded relief map for the extrusive volcanic.* **b)** *Shaded relief map for one of the intrusive volcanic from a vertical seismic section.*

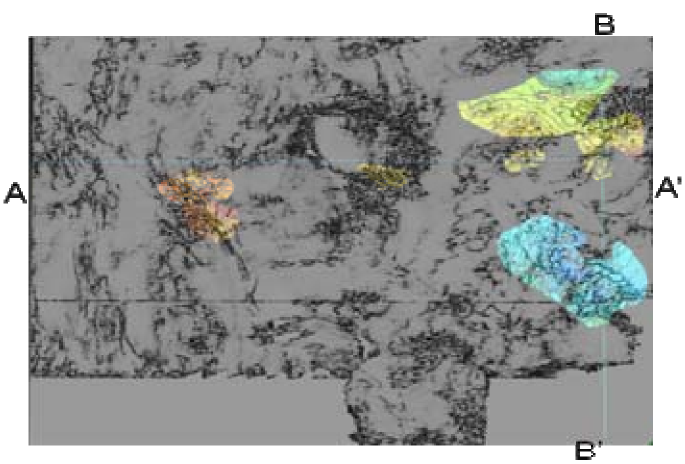


Figure 6. *Blended image of the time structure map with the coherence image at t=1.335 s. Note the correlation between the location of some of the volcanic sills and the data quality (incoherent zones) deeper in the section.*

Conclusion

Although the exploration objective in the Amatitlán survey area is primarily to map the Chicontepec Formation, this objective is handicapped by the presence of shallow volcanics that disrupt the deeper signal. Sills that are intruded parallel to stratigraphic horizons cause fewer problems in deeper seismic data. However, sills that cut upward from horizon to horizon as well as stacked sills, are correlated to low coherence seismic at depth. Several of the sills give rise to strong interbed multiples which cut across deeper reflections of interest.

The Chincontepec Formation is composed of low-permeability turbidites and sheet sands that are encased in a shale matrix and cut by incoherent mass transport complexes. Geomorphological recognition of turbidites and mass transport complex is made by their relatively chaotic texture as seen on seismic attributes. This pattern is overprinted by the chaotic nature of the seismic data associated with the overlying volcanics. At present, our objective is to map these ‘poor data quality’ zones and thereby risk-weight our texture-based interpretation of the Chicontepec Formation. Our next step is to evaluate the potential correlation of permeability measured in wells to proximity to volcanics.

Acknowledgements

We thank PEMEX Exploración y Producción for permission to publish this work and particularly to Juan M. Berlanga, Proyecto Aceite Terciario del Golfo, PEMEX Exploración y Producción, for making our work possible through access to seismic data, support for the data reprocessing and bits of help along the way. We also thank Bunmi Elebiju and Bradley Wallet at OU for helping with the magnetic data and topographic information. Finally, we would like to thank Roger Slatt and Gustavo Diaz for providing helpful information about the geology of the area.

Geophysical Evidence of Basement Controlled Faulting in the Ellenburger Group and Viola Limestone, Fort Worth Basin, Texas



Elizabeth Baruch, Olubunmi O. Elebiju, and Roderick Perez
ConocoPhillips School of Geology and Geophysics, University of Oklahoma

Summary

The Fort Worth Basin (FWB) is a shallow north – south elongated foreland basin, encompassing roughly 15,000 sq. mi in north Texas. It formed during the late Paleozoic Ouachita orogeny (Walper, 1982) and displays a complex structural basement mainly due to the collision of the North and South American plates during the Paleozoic.

This work compares horizontal derivative of the tilt derivative maps (HD_TDR), seismic attributes including most positive curvature and image enhancing over most positive curvature-sliced along the Viola Lm. and Ellenburger Group horizons, and azimuth frequency diagrams (rose diagrams) for two different areas in order to compare the Maximum and Minimum Horizontal stress of lineaments related to collapse structures, and faults and fracture patterns at specific horizons with the discontinuities in the basement.

The main conclusion of this work is that intra-sedimentary features such as collapse structures, faults and fracture patterns for the Viola Lm. and Ellenburger Group horizons are mainly related to basement structures because they tend to align along these discontinuities.

Introduction

The Fort Worth Basin (FWB) is a shallow north – south elongated foreland basin, encompassing roughly 15,000 sq. mi in north Texas. It formed during the late Paleozoic Ouachita orogeny (Walper, 1982) due to collision of the North and South American plates during the Paleozoic. This collision continued during the early Pennsylvanian and caused overthrusting along the eastern margin of the basin, the formation of the Ouachita structural front, and the onset of the orogeny. The basin is delimited in the east by the Ouachita Thrust Front, to the north by the Red River Arch, to the north – northeast by the Muenster Arch, to the west by the Bend Arch, Eastern shelf and Concho Arch, and to the south by the Llano Uplift **(Figure 1).**

Although the FWB is considered to be a mature basin and has been extensively explored for hydrocarbons, very little has been published about its basement. Sullivan et al. 2006,

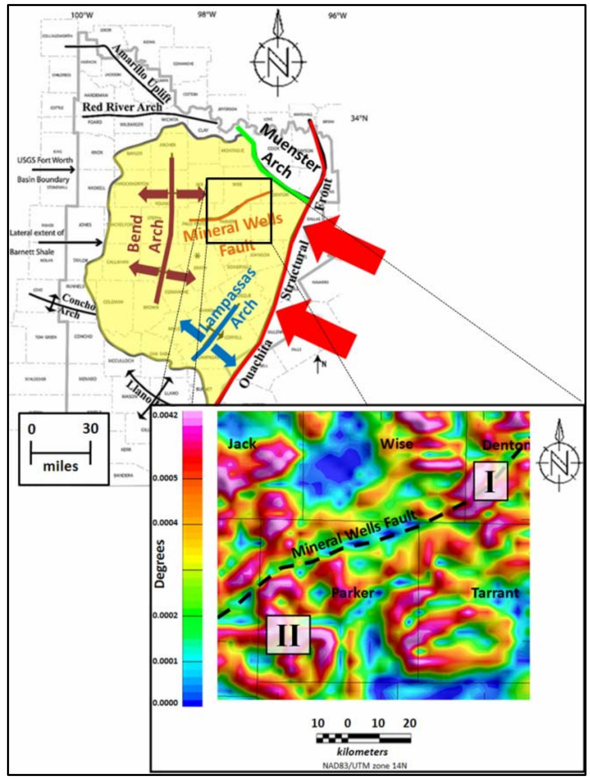


Figure 1: *Main structural features in the FWB (Modified from Pollastro, 2007) and the horizontal derivative of the magnetic tilt derivative map of the area.*

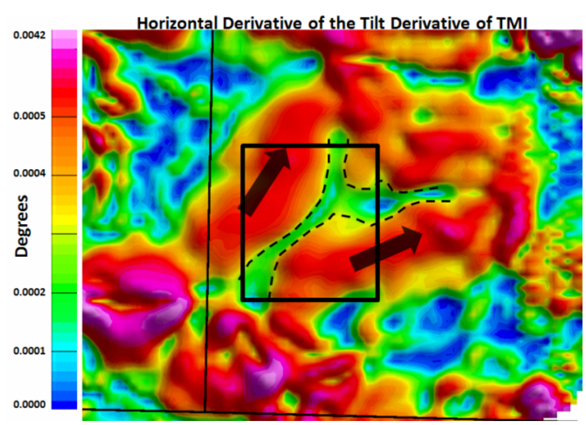


Figure 2: *Detail of the HD_TDR map corresponding to seismic survey 1 area.*

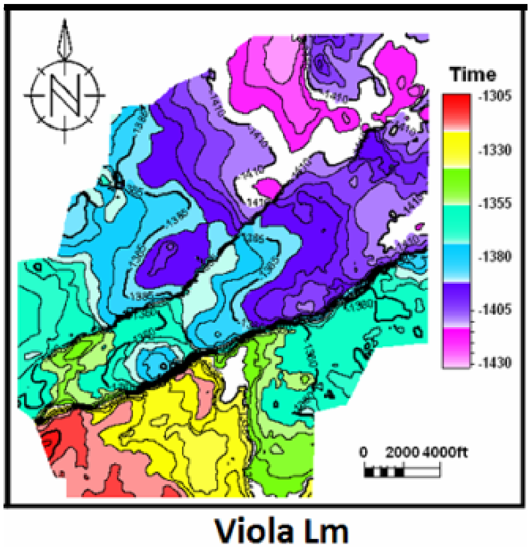


Figure 3: Time-structure map corresponding to the Viola Lm for seismic survey 1.

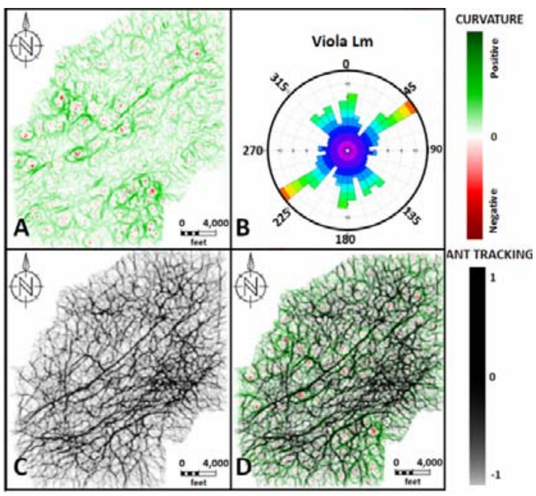


Figure 4: (a) Horizon slice along the top Viola Lm through the most-positive curvature volume for survey 1, and (b) its corresponding rose diagram, (c) image enahncement of (a), and (d) superposition of (a) and (c).

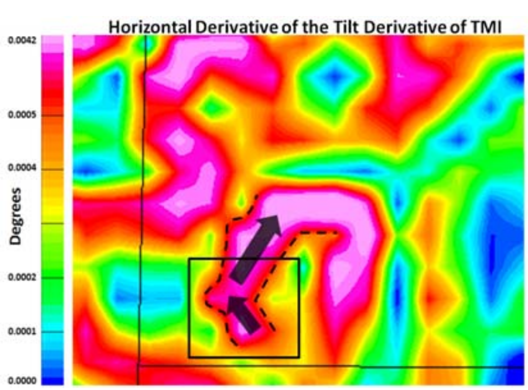


Figure 5: Detail of the HD_TDR map corresponding to seismic survey 2.

hypothesizes that the basement influences collapse features and fracture patterns in shallower horizons and Aktepe et al. (2008) used pre-stack depth migration data to show that basement structures can be quite complex.

Figure 1 reveals the complexity of the basement in the area of study. The black dashed line shows the location of the most prominent structural element known as the Mineral Wells fault (MWF). This MWF is a major northeast-southwest striking fault extending for more than 65 miles (100 km). It is a normal fault with a strike-slip component.

For this work, horizontal gradient magnitude (HMG) maps were generated from high resolution aeromagnetic (HRAM) data. HMG maps derived from HRAM data reflects abrupt lateral changes in magnetization in the area (Elebiju, 2008) and the tilt derivative (TD) maps help to enhance the continuity of such anomaly if it is close to a magnetic source. Thus, the horizontal derivative of the tilt derivative map (HD_TDR) enhances prominent edges of a magnetic source that could be related to faults and discontinuities in the basement.

Derivative maps are designated to enhance edges of magnetic sources providing better understanding of basement intra-sedimentary features. These features might be hard to resolve using just HRAM considering that they are usually non-magnetic or very low in magnetization.

This paper shows the integration of magnetic data with seismic attributes extracted along the Viola Limestone for survey 1 and the Ellenburger Group for survey 2 and compares Maximum Horizontal stress (MHS) and Minimum Horizontal stress (mHS) of lineaments related to faults and fracture patterns with the discontinuities in the basement.

Seismic Attributes and Image Enhancement

In addition to other attributes including coherence and acoustic impedance, we computed most positive and most negative curvature volumes and sliced them along the appropriate horizon. We found most positive curvature attribute to be a most useful tool in identifying polygonal compartments containing collapse features (typically, karst), in the FWB. These collapse features can be recognized as negative values of most-positive curvature indicating bowl-shaped features **(Figure 4a and 7a).**

To enhance linear features in most-positive curvature volumes we applied a commercial "ant-tracking" algorithm described by Pedersen el at. (2002), then constructed azimuth frequency rose diagrams by picking the individual lineaments with the goal of analyzing their directional trend for each horizon. Each petal in the rose diagram corresponds to 10 degrees.

Cases of Study

Survey 1.

The first seismic survey is located in the northern part of the FWB, close to the Muenster Arch, where the basin reaches its maximum depth. The main structural element present in the area is the MWF. **Figure 2** shows the boundaries of the seismic survey 1, and the main structural elements present in the area. Black-dashed lines show the location and extent of the MWF.

Figure 3 shows the time-structure map corresponding to the Viola Lm for seismic survey 1. Notice that the horizon dips to the northeast side of the FWB and shows two NE-SW branches of the MWF.

Figure 4 shows the result of the most-positive curvature and rose diagram of the most-positive curvature attribute corresponding to the Viola Lm. The lineaments corresponding to the Viola Lm. show a preferential direction (MHS) close to 45 degrees. This trend matches the direction of the main structural element in the area, in this case the MWF.

Survey 2.

The second seismic survey is located in the southern part of the FWB and south of the MWF, where the basin is shallower. In this case there are no prominent structural elements present. **Figure 5** shows the boundaries of seismic survey 2, and two major trends with directions NE-SW and NW-SE. These trends are not associated with any major structural element in the area.

Figure 6 shows the time-structure map corresponding to the Ellenburger Group for seismic survey 2. The horizon shows a preferential area of low relief trending NE-SW.

Figure 7 shows the result of the most-positive curvature and rose diagram of the most-positive curvature attribute corresponding to the Ellenburger Group.

The lineaments corresponding to the Ellenburger Group show a preferential direction close to 45 degrees and a secondary direction close to 315 degrees. These trends match with the direction of the major trends in the basement and are not associated with any major structural element in the area.

Result Analysis / Conclusions

For surveys 1 and 2, the results allow us to infer that the maximum horizontal stress (MHS) at the time of structural deformation remained fairly constant between the basement-Viola Lm and basement-Ellenburger Group horizons, respectively. Also in the azimuth frequency diagram (rose diagram) for the Viola Lm., the minimum horizon stress (mHS) is not perpendicular to the MHS, and is divided into two NS and NW to SE components. In the case of the Ellenburger Group, the azimuth frequency diagram (rose diagram) shows a similar pattern for the mHs, but just one major component trending NW-SE.

Normally, it is possible to estimate stress through break outs in image logs, velocity anisotropy, and microseismic emissions for fractures. In this research we design a workflow in order to use independent geophysical measures to estimate the stress at the time of structural deformation for two different regions in the FWB.

In this work we demonstrate the importance of mapping the basement in order to understand the lineaments pattern of some of the naturally induced fractures in the FWB.

In both examples we conclude that the intra-sedimentary features such as collapse structures in limestone formations are mainly related to basement structures and tend to align along these discontinuities.

ACKNOWLEDGEMENTS

Thanks go to Devon Energy for providing us with 3D seismic surveys and the high resolution aeromagnetic data for our research and for this publication. Thanks to Schlumberger for providing OU with licenses to Petrel. The image enhancement was done using Schlumberger's ant-tracking© algorithm. Finally, our sincere appreciation goes to Dr. Roger Slatt, Dr. Kurt Marfurt, and Dr. Randy Keller for their continuous support and timely suggestions.

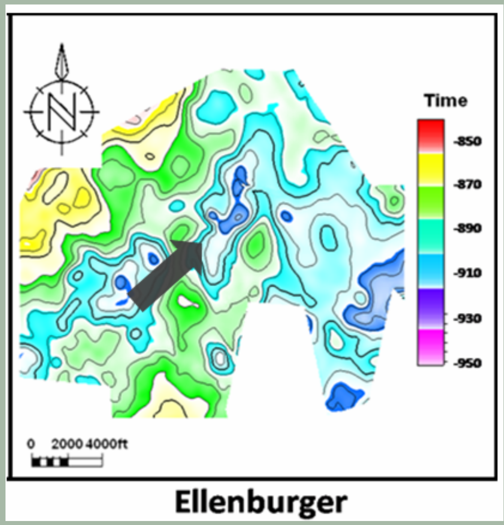


Figure 6. *Time-structure maps corresponding to the basement and Ellenburger Group for seismic survey 2.*

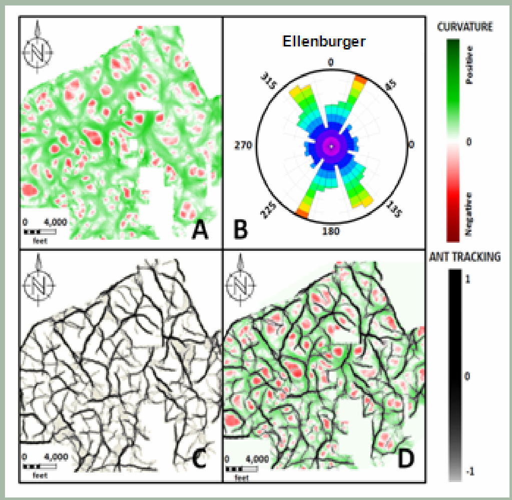


Figure 7. *(a) Horizon slice along the top Ellenburger Group through the most positive curvature volume for survey 2; (b) its corresponding rose diagram; (c) image enhancement of (a); and (d) superposition of (a) and (c).*

References

Elebiju, O. O., Keller, G. R., and Marfurt, K. J., 2008, New structural mapping of basement features in the Fort Worth Basin, Texas, using high-resolution aeromagnetic derivatives and Euler depth estimates: 78th Annual Meeting, SEG Expanded Abstract.

Pedersen, S. I., T. Randen, L. Sonneland, and O. Steen, 2002, Automatic 3D Fault interpretation by artificial ants: 64th Meeting, EAEG Expanded Abstracts, G037.

Pollastro, R. M., 2007, Geologic framework of the Mississippian Barnett Shale, Barnett – Paleozoic total petroleum system, Bend Arch-Forth Worth Basin, TX: AAPG Bulletin, 91, No 4, 405–436.

Sullivan et al., 2006, Application of new seismic attributes to collapse chimneys in the Fort Worth Basin: Geophysics, Volume 71,pp. B111-B119.

Walper, J.L., 1982, Plate tectonic evolution of the Forth Worth Basin, *in* C. A. Martin, ed., Petroleum geology of the Forth Worth Basin and Bend Arch area: Dallas Geological Society, 237–251.

Mass Transport Complex in Salt Minibasin—Sequence Stratigraphy, Seismic Geomorphologic and Local Tectonics Aspects: A Case Study from Northern Gulf of Mexico

Supratik Sarkar, *ConocoPhillips School of Geology and Geophysics, University of Oklahoma*

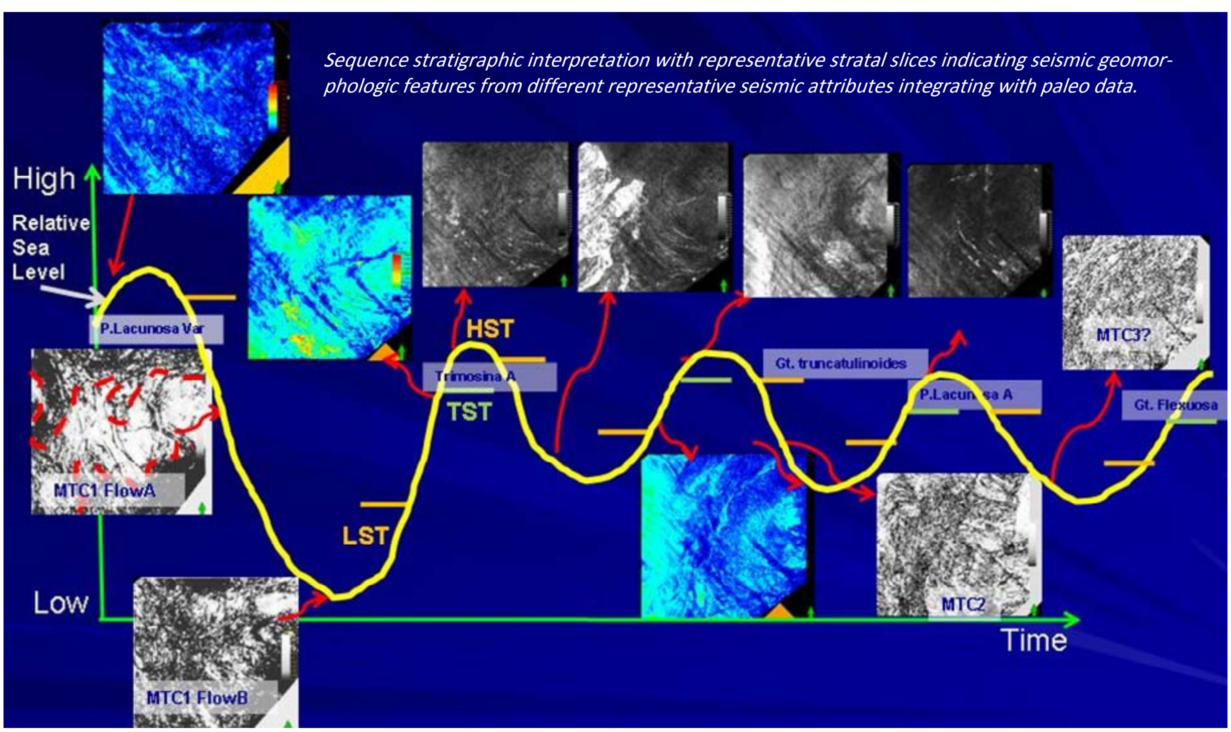
PhD Candidate

Salt minibasin provinces are important exploration zones in the deep water Gulf of Mexico. Although mass transport complexes (MTC) are rarely considered as primary exploration targets, they are very important in many other aspects, such as determining the depositional history and sequence stratigraphic framework of a basin and the impact they create upon overlying and underlying units. A 100 square kilometer 3D seismic dataset has been analyzed along with well logs and micropaleontologic information from a salt minibasin that falls within the tabular salt minibasin tectono-stratigraphic province (Diegel et al, 1995) of the Gulf of Mexico.

Seismic interpretation reveals that the MTCs within the minibasin are not only affected by sea level fluctuation and regional tectonics, but also by local tectonics due to salt movement. Several seismic attributes, including RMS amplitude, inline and crossline amplitude gradients, Sobel filter edge detector, coherence, most positive and negative curvature and spectral decomposition have been applied to the 3D seismic data. Stratal slices from these attributes reveal several seismic geomorphologic features within MTCs as well as within overlying and underlying strata which help to reconstruct the sequence stratigraphic framework and depositional history of the minibasin.

Attribute analysis indicates two different units within a larger MTC, each with different seismic characteristics. The lower unit might be part of a regional-scale mass flow. The upper unit is more erosive and chaotic in nature, containing some discontinuous features suggesting intensified local salt tectonics and slumping. Salt movement produced several arcuate extensional faults within the MTC, some of which extend to shallower sequences A few toe thrust related faults due to thrust impact of the MTC are present.

The intense tectonic activity and rapid basin fill rate during deposition of the upper unit might have changed the depositional pattern and dominant sediment transport direction as revealed by seismic attributes. Rare striations at the base of the MTC and a train of high amplitude blocks were also imaged by different attributes. Using detailed analysis of small seismic geomorphologic features within a conventional seismic data interpretation workflow augmented with well log information, we build a sequence stratigraphic framework of the minibasin with emphasis on two MTCs.



Sequence stratigraphic interpretation with representative stratal slices indicating seismic geomorphologic features from different representative seismic attributes integrating with paleo data.

Characterization of Organic and Inorganic Parameters of a Tertiary Source Rock Core from an Exploration Well in the Stratigraphic Interval Between 2500 and 3300 feet, in the Eastern Basin of Venezuela

Lo Mónaco Guillermo[1], Dr. López Liliana[2]

[1]The University of Oklahoma, ConocoPhillips School of Geology and Geophysics,
[2]Universidad Central de Venezuela, Instituto de Ciencias de la Tierra.

The present study was intended to characterize Tertiary lutitic rocks located in the eastern basin of Venezuela. A range of samples from 2500 to 3300 feet were analyzed with specific attention directed towards the physicochemical parameters of asphaltene such as average molecular weight (Mw) and molecular number (Mn), and various Rock Eval pyrolysis parameters that are indicators of maturity, quality, origin and generation capacity of the source rocks **(Figure 1)**. Selected samples were all analyzed using a petrographic microscope and scanning electron microscope (SEM) to characterize the mineralogy of the samples and observe the morphology of the clay minerals **(Figure 2)**; moreover, this technique showed clear evidence that the clay mineralogy changed due to the temperature increasing during the thermal evolution **(Figure 3)**. In addition, using the X-ray diffraction (XRD) results, conducted by Torrealba (2002) on the same samples, a geothermal model was applied to the difractograms of clay minerals **(Figure 4)** in order to establish the degree of diagenesis of these minerals and to compare it with the maturity of the rock obtained by Rock Eval pyrolysis. The maturity determined for the selected samples from both types of analysis was very similar **(Figure 5)**. The results of the analysis indicated that the rocks analyzed in this depth range have a maturity ranging from late diagenesis to catagenesis (oil window). Some of the samples have good to excellent potential for hydrocarbon generation and were cataloged as a good source rock, using pyrolysis parameters like total organic carbon (%TOC) **(Table 1)**. The increments of the molecular weights of the asphaltenes from the gel permeation chromatography (GPC) analysis indicated that the main process that occurred during the maturity of this rock was the aromatization of the hydrocarbons, shown by the molecular weight increase during the increasing temperature due a aromatization of the polycyclic molecules, which increases the molecular weight of the asphaltene fraction **(Figure 6)**. Further studies like organic petrography confirmed the terrestrial organic matter input already established by Rock Eval pyrolysis parameters.

Lo Mónaco Guillermo
Geology Masters

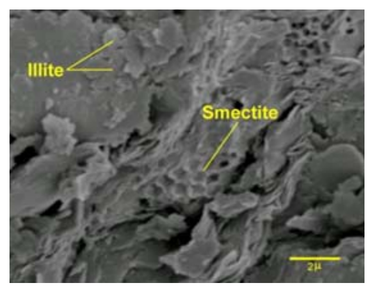


Figure 2. *Some clay minerals identified through scanning electron microscope (SEM)*

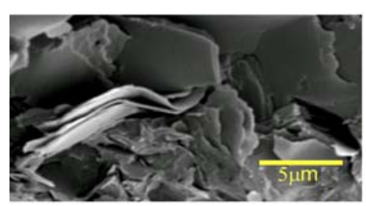


Figure 3. *Changes in clay minerals morphology due to the thermal evolution identified through scanning electron microscope (SEM)*

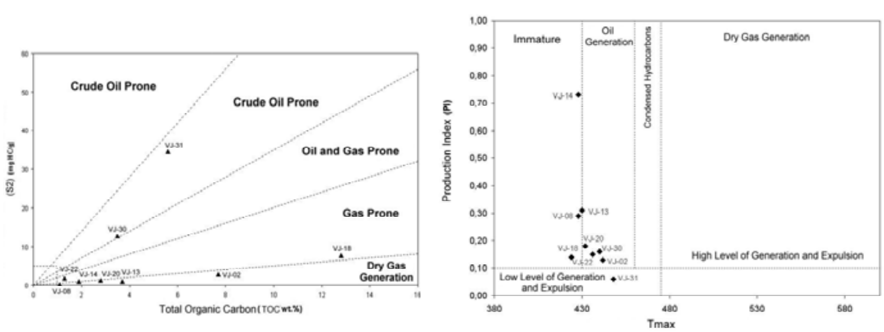


Figure 1. *Rock Eval pyrolysis parameters plots, showing maturity, origin and generation capacity of the source rocks*

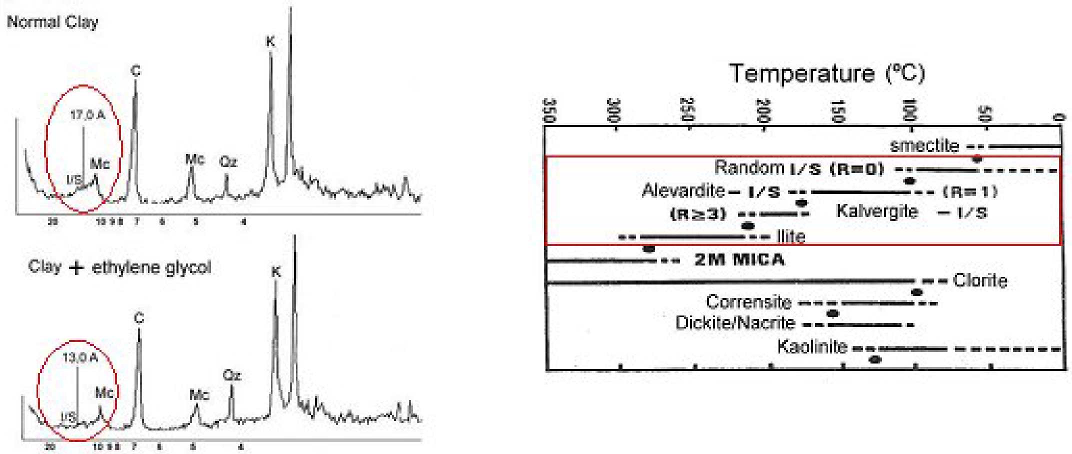


Figure 4. *X-ray diffraction (XRD) results, conducted by Torrealba (2002) on the same samples, and the geothermal model proposed by Hoffman and Hower (1979), which were applied to the difractograms of clay minerals*

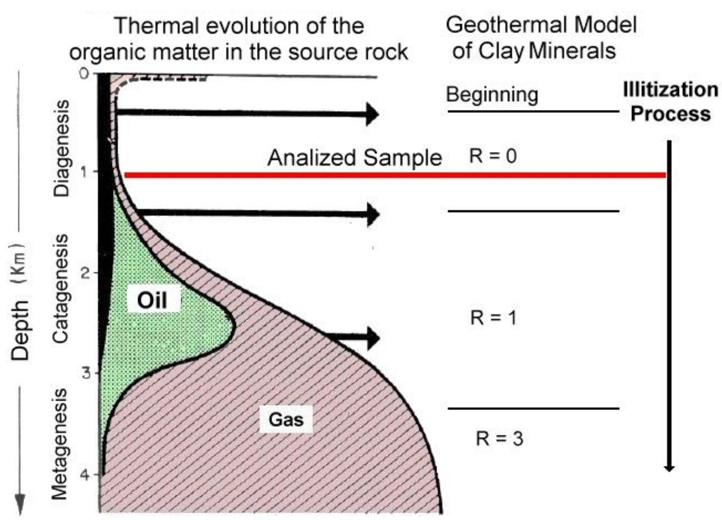


Figure 5. *Comparison of source rock thermal evolution with crystalline rearrangement of clay minerals (modified from Tissot and Welte, 1984)*

Quality of Source Rock	Depth (Ft)	%TOC
Good	2649	1,90
Excellent	2651	3,70
Excellent	2555	7,70
Excellent	2768	12,80
Good	2771	2,80
Good	2774	1,30
Excellent	3288	5,60

Table 1. *Total organic carbon (%TOC) variation with the depth relative to the quality of source rock.*

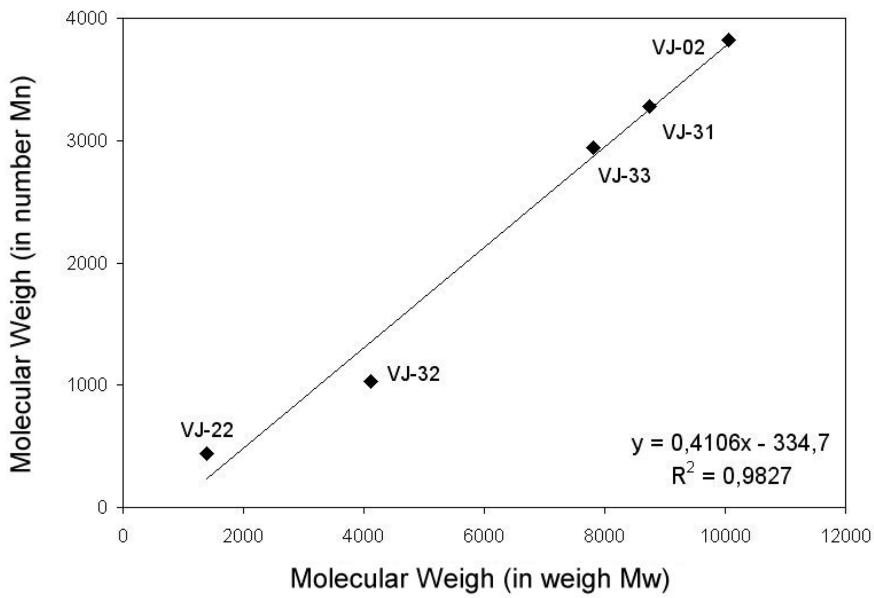


Figure 6. *The polydispersity of the samples ensures they all have similar characteristics in terms of their chemical composition and structure. It also indicates that all samples were subjected to the same conditions of temperatures and pressures during the source rock maturation.*

References

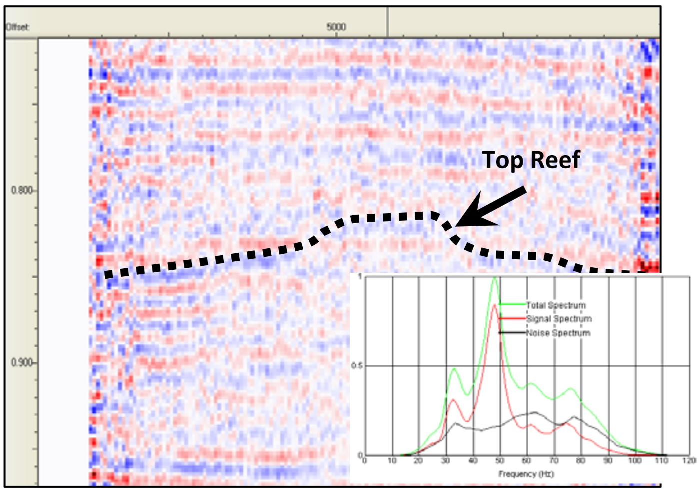
- Hoffman, J. and Hower, J., 1979 Clay mineral assemblage as low grade metamorphic geothermometer: Application in the thrust faulted Disturbed Belt of Montana, USA: Aspect of diagenesis, in Peter A. A. Scholled and Paul R. Schluger, eds. SEPM Special Publication 26, p. 55-79.

- Tissot, B. and Welte D., 1984. Petroleum Formation and Ocurrence: Springer-Verlag, Berlin, Heidelberg, New York, Tokyo, 699 p.

- Torrealba, J., 2002. Caracterización Geoquímica de las arcilla de la Formación Carapita, Cuenca Oriental de Venezuela. Universidad Central de Venezuela. Facultad de Ciencias. Instituto de Ciencias de la Tierra. Proyecto Geoquímico. 90.

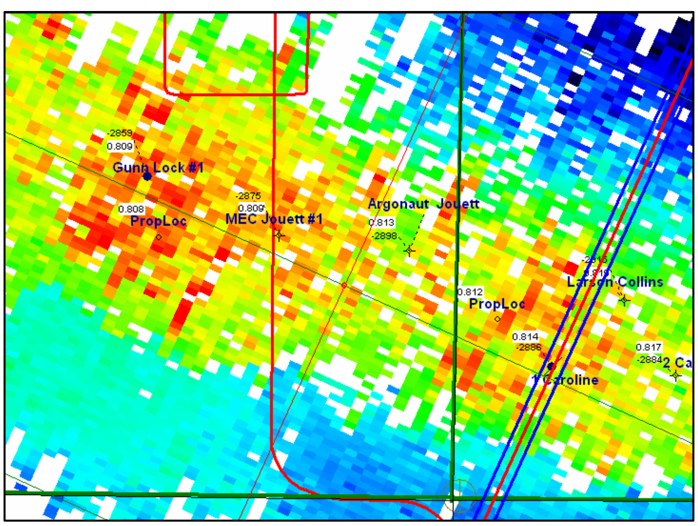
John M. Hooper, Michael D. Burnett, Dr. R. Paul Philp, and Dr. Roger M. Slatt

Reservoir Characterization in a Mature Canyon Reef Trend



Raw PSTM stack

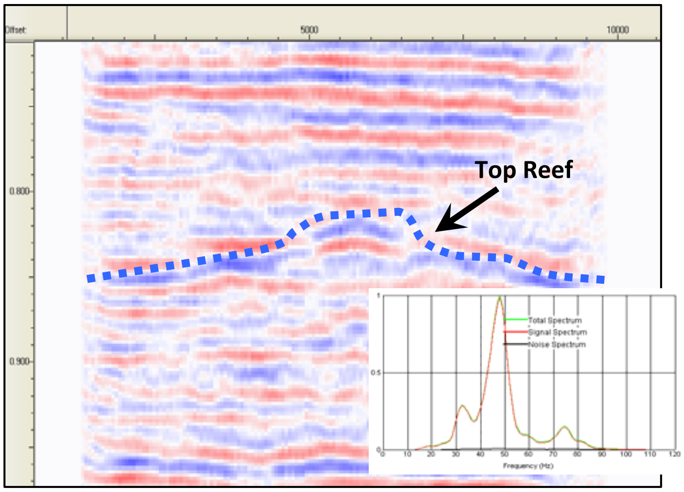
The Upper Pennsylvanian Canyon reef trend associated with the Kirkland Field was discovered in approximately 1960 by Gunn Oil Company, utilizing single fold 2D seismic data. The trend was extended over the next 48 years by drilling on 2D and 3D multi-fold seismic data. In the last two years, the reservoir characterization was significantly enhanced by improvements in prestack seismic data conditioning, resulting in seismic images of interpreted tidal channels which were not detectable on prior versions of data processing. These tidal cuts clearly separate the reef into isolated reservoir compartments. Structure maps on the top of reef and the top of porosity underlying the tight lime cap were made from an integrated interpretation of well tops and prestack conditioned 3D seismic data followed by cokriging the seismic depth interpretation with the well tops.



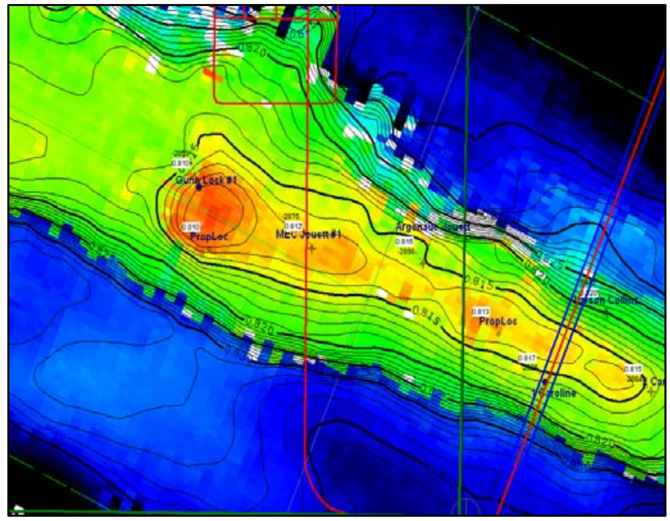
Top reef from raw PSTM Stack (no conditioning)

Two wells were completed as oil producers in 2008. These wells were tested, primarily on the strength of the integrated structure map and favorable petrophysical and DST analysis in the planned reentry well. Rigorous multi-mineral petrophysical analysis and cased hole interpretations were combined with DST data, mudlogs, and sequential testing in the evaluation and completion of these two wells. This work resulted in the observations that there was water above oil in one of the wells and that fracturing into the lime cap was not ubiquitous.

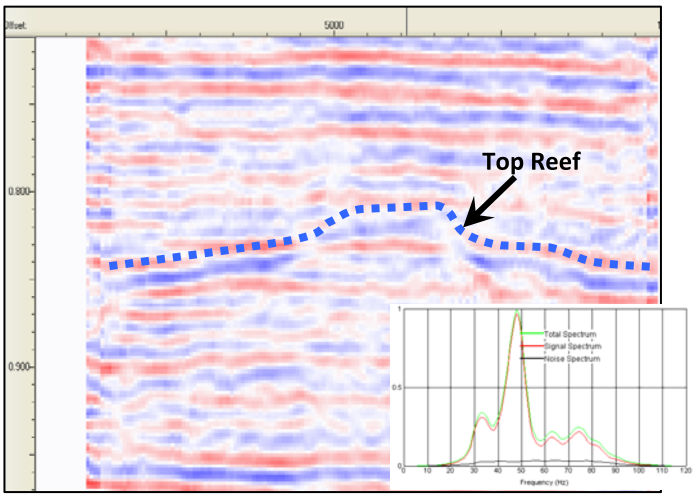
Statistical treatment of GCMS geochemical analysis demonstrates clear evidence of measurement repeatability, but significant differences in the oil composition between wells. The differences between wells may result from reservoir compartmentalization.



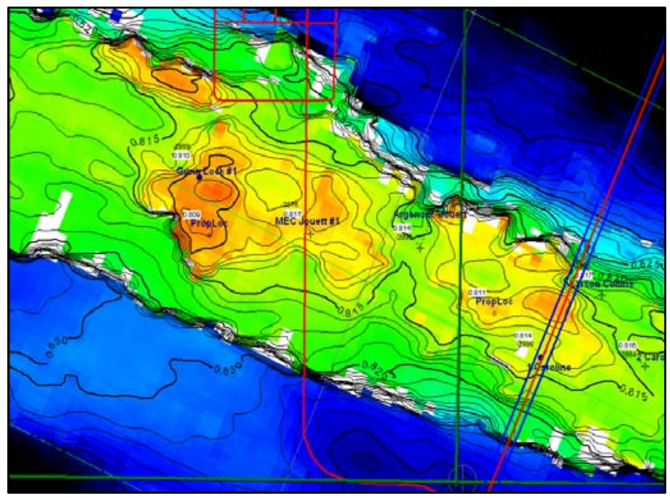
Raw stack with FXY (3 – trc)



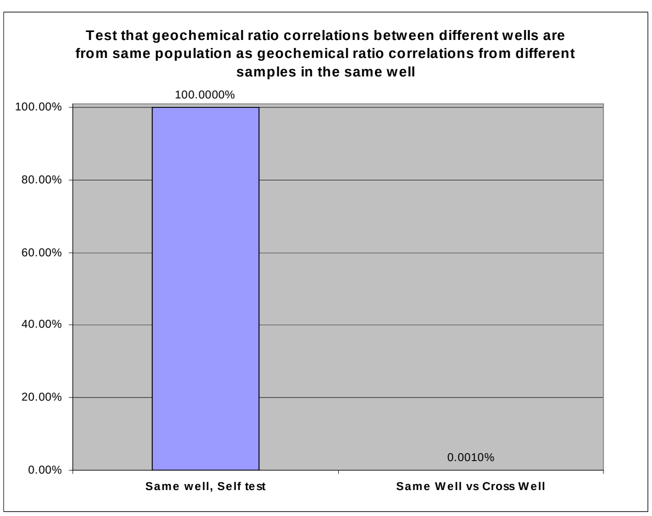
Top reef from standard (FXY) post stack conditioning

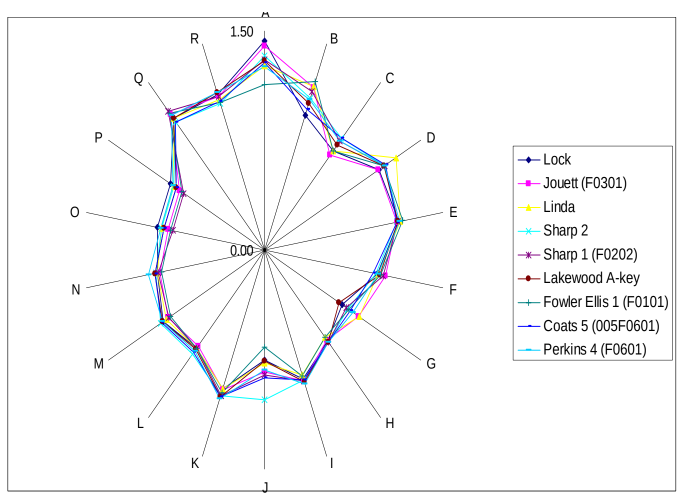


Raw with STAC prestack conditioning



Top reef from STAC processing





Spider plot of Peak Ratios from gas chromatography of oil samples

Roderick Perez, *ConocoPhillips School of Geology and Geophysics, University of Oklahoma*

M.S. Thesis: Quantitative Petrophysical Characterization of the Barnett Shale (Newark East Field, Fort Worth Basin)

The purpose of this study is to identify which facies of the Barnett Shale are most fracturable. The study includes a 100 square-mile three-dimensional seismic survey and 164 wells, encompassing an area close to 120,000 square miles. The area of study was conducted in Denton County; Ft. Worth Basin, Texas. In this area, the Barnett Shale thickens from NNE to SSW.

The Barnett Shale reservoir is characterized by low permeability and a variety of depositional facies. Based on gamma ray behavior it can be divided into fourteen gamma ray parasequences (GRP) corresponding to five in the Upper Barnett Shale and nine in the Lower Barnett Shale. In addition, these fourteen GRPs show three characteristic GR log patterns defined as upward decreasing, upward increasing, and upward constant trends. These two main zones are divided by the Forestburg Limestone, which acts as a fracture barrier during hydraulic fracturing.

The study emphasizes volumetric seismic attributes, such as curvature, coherency, and inversion, to identify and evaluate faults, fracture lineaments, and other features in the Barnett section. The Barnett section within the study has a thickness around 700 ft, which represents 200 ms in seismic time. With an average frequency spectrum of 45 Hz, it is difficult to resolve internal reflections less than 70 ft thick. Model based inversion was used in order to improve the vertical seismic resolution and to tie in detailed facies core descriptions. The seismic information and vertical well control data played an essential role in the creation of synthetic seismograms to get quality results in the facies model.

This work demonstrates that seismic acoustic impedance inversion reveals high heterogeneity in impedance values for the Lower and Upper Barnett section **(Figure 1)**. The underlying hypothesis used in this thesis is that it takes longer for seismic waves to travel through some lithofacies and lesser time in others. Under this criterion, the seismic inversion method was used to analyze the variation in acoustic impedance response among the different gamma ray parasequences. Core studies performed by Singh (2008) show that facies with high calcite content (concretions) contain well-defined fractures, indicating that they are fracturable. Thus, we expect that those facies with high calcite content and high impedance might potentially be more fracturable than non-calcite mudstones. The correlation of seismic facies with rock facies is key in this research in order to seismically identify parasequences that could potentially be more fracturable.

Finally, this thesis work follows a workflow that allows the identification of facies with high gamma ray and high calcite content (high impedance) in order to identify potentially most fracturable GRPs in the Barnett Shale.

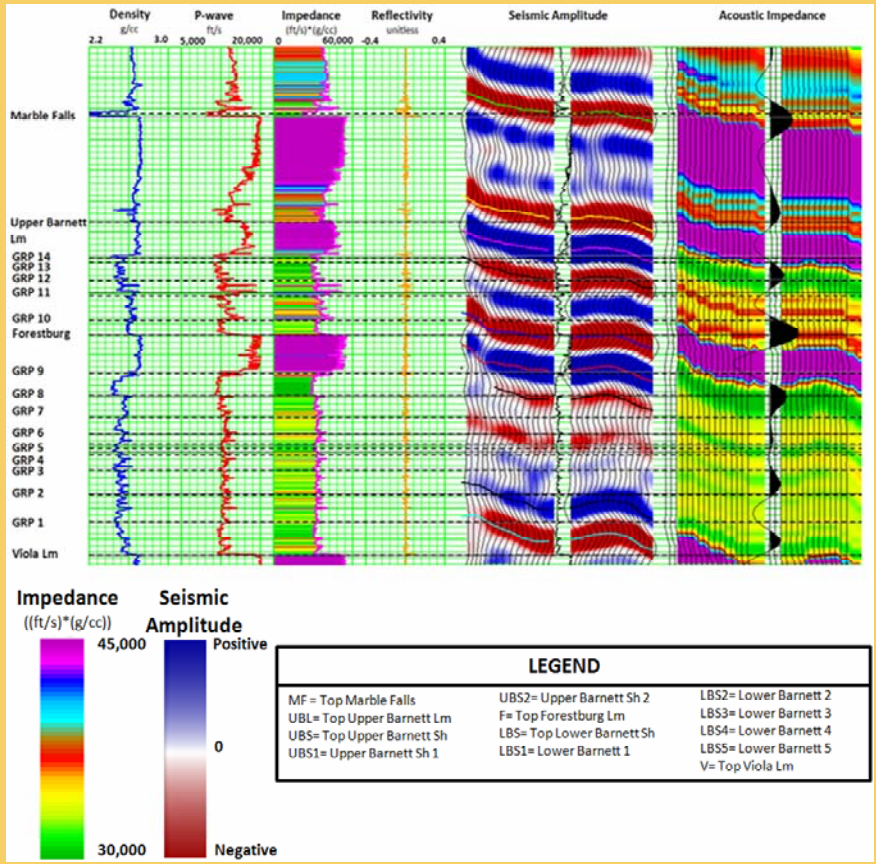


Figure 1. *Results comparison between seismic amplitude, acoustic impedance inversion with GRP well tops.*

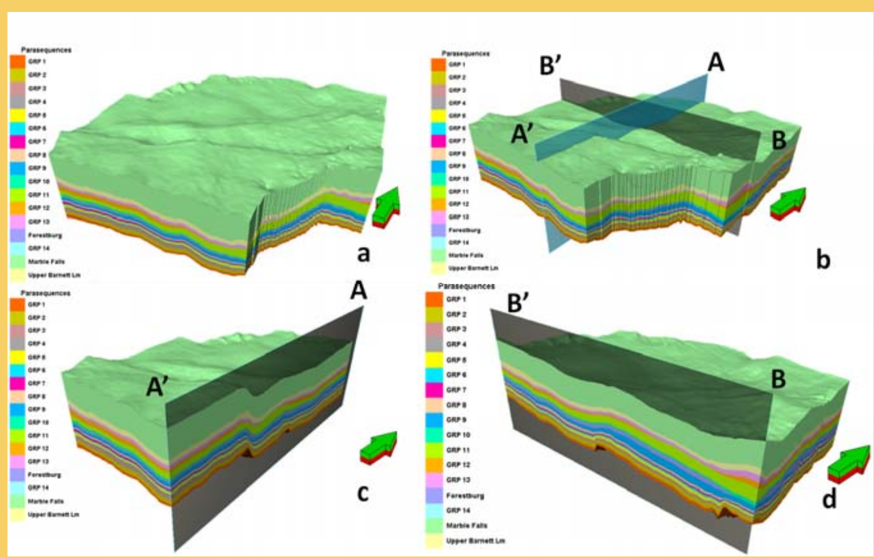


Figure 2. *General view of the parasequences 3D geological model, b) cross section A—A', and B—B' location, c) A—A' cross section, and d) B—B' cross section.*

Seismic Attribute Expression of Chert Reservoirs from Osage County, Northeast Oklahoma

Bunmi Elebiju* *and Shane Matson*[¥]
** ConocoPhillips School of Geology and Geophysics, University of Oklahoma, Norman, Oklahoma.*
[¥] *Spyglass Energy Group, LLC, Tulsa, Oklahoma*

Summary

Osage County, Oklahoma has been a prolific oil producing area since the discovery of the giant Burbank field in 1918. We have used the integration of gravity, magnetic, and 3D seismic data to map features in the sedimentary column and to study relationships between sedimentary and basement features in the Osage County area. Volumetric seismic attributes such as coherence, curvature, and amplitude gradient derived from 3D seismic data were employed to better characterize subtle features such as collapse features, faulting and fracturing, and hydrothermal alteration within the carbonate reservoirs that are difficult to image using conventional 3D seismic data analysis techniques. We conducted an integrated analysis that includes the use of 3D seismic data, seismic attributes, and derivative maps from potential field data to study the Mississippi Chert and the Arbuckle Group of Osage County, Oklahoma. Seismic attribute analysis of the Osage County carbonate reservoirs was effective in studying and identifying polygonal, highly coherent, and high amplitude lineaments that strike northwesterly and northeasterly within these reservoirs. The fracture lineament densities increase from the Mississippi Chert toward the Arbuckle Group and reduce toward the Reagan Sandstone. Basement structure lineaments were found to be parallel in orientation with the trend of lineaments seen within the Mississippian and Arbuckle Group. The northwest-striking lineaments are suggested to be related to the late-Paleozoic tectonism that affected both the Precambrian and Paleozoic section of Osage County. On the other hand, the northeast lineaments are related to the inherent structural fabric of the basement rock.

Introduction

Osage County is located in northeastern Oklahoma and is bounded by the Ozark Uplift to the east, the Nemaha Uplift to the west, the Kansas state boundary to the north, and the Arkansas River to the southwest. This county is part of the gently west-southwest - sloping stable shelf, which extends into the Anadarko and Arkoma Basins from the Ozark Uplift (Thorman and Hibpshman, 1979) (Figure 1).

Independent operators have used conventional interpretation methodology from 3D seismic data to explore the Mid-Continent carbonate reservoirs. Increasingly, volumetric seismic attributes such as coherence, curvature, and amplitude gradients calculated from the 3D seismic data are being incorporated into the Mid-Continent exploration workflow to better characterize carbonate features such as karsting, tectonic faulting and fracturing, and hydrothermal dissolution that are difficult to image from standard 3D seismic data (e.g. Nissen et al., 2006).

In this paper, we present the results of potential field and seismic data analysis from several 3D seismic surveys acquired in Osage County, Oklahoma. Our efforts are directed at the Ordovician Arbuckle Group and the Mississippian Chert reservoirs that have been diagenetically altered by tectonic faulting and fracturing, subaerial exposure, and hydrothermal alteration processes. Our objective is to understand the interaction between Precambrian structures and the fracture controlled carbonate reservoirs. We attempt to establish an association between these structures and the karst reservoirs. In addition, features identified within the Precambrian basement were compared with features within the sedimentary section as we examine possible links between these features. We believe that the results of this study will be useful in exploration for these reservoirs.

Methodology

Interpretation of gravity and aeromagnetic datasets provided basement information. Various derivative maps generated from the aeromagnetic data enhance lateral and abrupt changes in magnetization, which indicate lateral changes in anomalies generally associated with basement faults. We computed the horizontal gradient magnitude (HGM), tilt derivative, horizontal derivative of the tilt derivative (Figure 2).

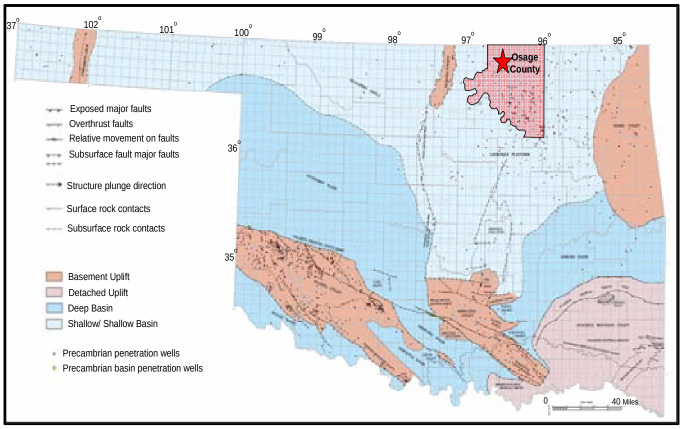


Figure 1: Map shows the major geologic provinces in Oklahoma. Red star indicates the location of the seismic data used for this study. Potential field data is from the area. (Map adapted from Northcutt and Campbell, 1995).

To understand the interaction between sedimentary features and structures within the Precambrian basement, we interpreted four different 3D seismic surveys that the Osage Nation and Spyglass Energy LLC provided us using modern interpretation software (Figure 1).

We began our interpretation by mapping the Arbuckle Group and the Mississippi Chert horizons. In addition to the time-structure map, we generated integrated seismic attributes for both horizons, which were designed to enhance geometric features such as fractures, faults, karst, and differential compaction that are not easily seen in the raw seismic data. The physical and geometrical features in the attribute use models of dip and azimuth, waveform similarity, amplitude, and frequency content from adjacent seismic samples, which can then be rendered on a computer for interpretation. Attributes that we found useful include coherence, most-negative and most-positive curvature, total energy and energy-weighted coherent amplitude gradients. Examples of their application and mathematical concepts are available in Chopra and Marfurt, 2007.

Mississippi Chert and Arbuckle Group Time-Structure and Seismic Attribute Mapping

We evaluated Mississippi and Arbuckle Group reservoirs comparing structures and lineations on both seismic and seismic attribute data. Structural mapping of both reservoirs shows generally southwest dipping undulating horizons (Figure 3). The chert horizons display an irregular surface that is typical in karsted carbonate regions. Structural complexity increases from the shallow Mississippi Chert to the deeper Arbuckle Group. We also noted an east-west feature in the southern portion of the seismic data (Figure 3).

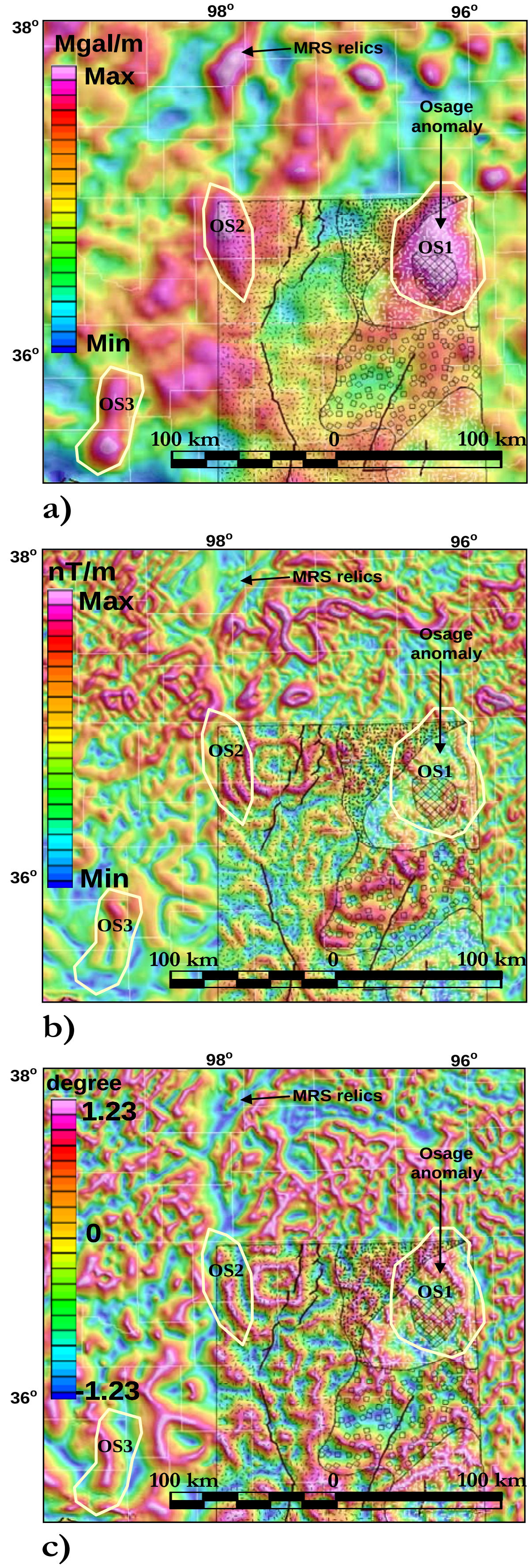


*Figure 2: Derivative maps computed on the residual gravity and total magnetic intensity (TMI) grid. **a)** 1st vertical derivative of residual gravity **b)** Horizontal gradient of magnitude of TMI **c)** Tilt deriviative of TMI.*

Coherence, curvature, total energy, and inline gradient attributes computed from the seismic data facilitates mapping of karst features and associated fracture patterns. The coherency horizon-slice map near the Mississippi Chert shows the presence of circular low-coherency features that we interpret as collapse features (red arrows on Figure 4a). At the Arbuckle Group level, the incoherent features are more dominant. We noticed that some of these low coherency features contain very coherent linear features (Figure 4b and c).

Figures 4e-h shows the most-negative horizon slice that enhances valley or bowl shaped features. We notice that most-negative curvature attributes enhance the lineaments that we interpret as fractures and faults. We also identified an increased number of lineaments especially at the top and within the Arbuckle Group (Figures 4e-h). We manually mapped most of the lineaments seen on the coherence and most-negative curvature horizon slices map and plotted them as a rose diagram. The rose diagram plots in Figures 4f-h inset indicate two sets of orthogonal lineaments (northeast-southwest and northwest-southeast). We suggest that the northeast striking lineaments are similar to the solution-enhanced faults and fractures reported by Nissen et al. (2006) in the Mississippian reservoir of the Dickman field in Kansas. The long anomalous northeast-striking lineament (yellow lineament) on the rose diagram is the fault seen on the southeast corner of the most-negative curvature horizon slice (Figures 4f-h).

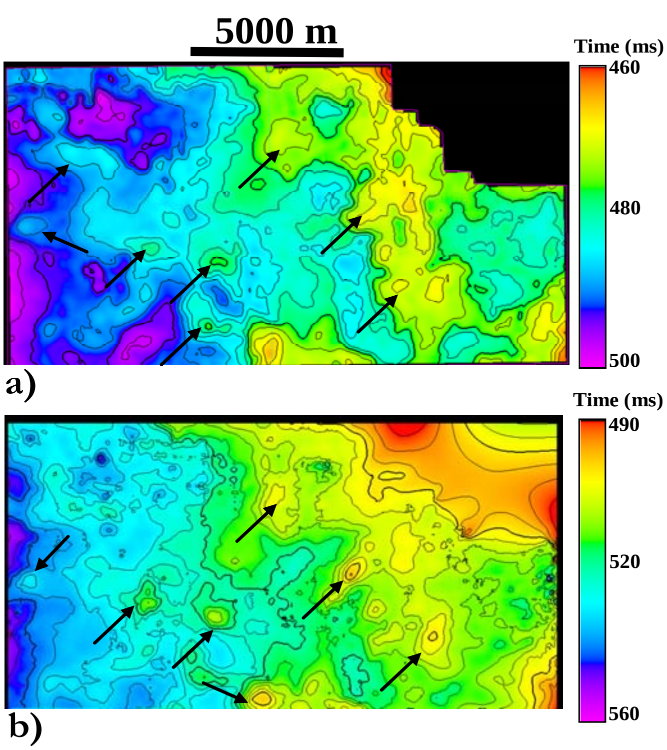


Figure 3: Time structure map on (a) the Mississippi Chert and (b) top of Arbuckle Group from two Osage County surveys. Map shows a general southeast dipping undulating and irregular surface. Features marked with black arrows are suggested to be residual hills associated with a karsted carbonate region

Based on our interpretation, the density of the northwest striking lineaments increases toward the top and below the Arbuckle Group (Figure 4e-h). However, lineament densities is reduced within the Reagan Sandstone that lies on top the basement rocks (Figure 4h). The blended image of the most-negative curvature (Figure 5a), the total energy (Figure 5b), and the coherence (Figure 4c) attributes with the inline gradient attribute (Figure 5c), show these lineaments to be nearly polygonal in shape. The lineaments occur as high amplitude and high total energy. Figure 5c also shows these lineaments to be highly coherent and we suggest that the amplitude and coherent nature of these lineaments can be due to the content material within them.

Thus, the seismic analysis has helped us deduce that lineaments over the Mississippi Chert and Arbuckle Group that have a general northeasterly and northwesterly strike. Our finding is consistent with a surface and subsurface remote sensing study of lineaments conducted by Guo and Carroll (1999). These authors also identified a northeast-southwest and northwest-southeast striking surface lineament, which correlated with subsurface lineaments.

Conclusion

This paper describes an integrated geophysical analysis that utilizes seismic data and potential field data to study Precambrian basement controls on carbonate reservoirs in Osage County in northeast Oklahoma. Seismic attribute analysis of the Mississippi Chert and the Arbuckle Group of Osage County was effective in studying and identifying lineaments within these reservoirs.

Our fracture analysis study on the most-negative curvature and rose diagram revealed that lineaments within the study area strike northeast-southwest and northwest-southeast. These lineaments are interpreted as fractures and their density increases are from the Mississippi Chert toward the Arbuckle Group but decreases from the Arbuckle Group toward the Reagan Sandstone. These lineaments also appear as polygonal and are highly coherent with high amplitude on the most-negative curvature, coherence, and total energy attributes respectively.

Basement structure lineaments were found to be parallel in orientation with the trend of lineaments seen within the Mississippian and Arbuckle Group. The northwest-striking lineaments are suggested to be related to the late-Paleozoic tectonism that affected both the Precambrian and Paleozoic section of Osage County. On the other hand, the northeast lineaments are related to the inherent structural grain of the basement rock. Thus, we suggest that the Precambrian basement controls the Mississippian Chert and Arbuckle Group reservoirs.

Acknowledgments

We express sincere thanks to the Osage Nation for the use of their seismic data for research and education. We also want to thank Charles Wickstrom and Shane Matson for access to more recently acquired proprietary surveys, and more importantly, for their geologic insight into the complexities of the Osage County region. Geosoft provided the education license for the potential field data processing and interpretation "Oasis Montaj". The seismic interpretation would not have been possible without the gracious donation of the Petrel interpretation software by Schlumberger. Ha Mai of Attribute Assisted Seismic Processing and Interpretation (AASPI) helped with the generation of codes used to compute the attributes. We thank Rockware for the online free trial of the RockWork14 demo-software used to generate the rose diagram. Lastly, we would like to thank the Oklahoma Geologic Survey for insightful geological comments and logistical support.

References

Guo, G., and H.B. Carroll, 1999, A new methodology for oil and gas exploration using remote sensing data and surface fracture analysis: Prepared for United States Department of Energy, Assistant Secretary for Fossil Energy.

Nissen, S. E., T.R. Carr, and K.J. Marfurt, 2006, Using new 3-D seismic attributes to identify subtle fracture trends in Mid-Continent Mississippian Carbonate Reservoirs: Dickman Field, Kansas: Search and Discovery Article #, **40189**.

Northcutt, R. A., and Campbell, J.A., 1995, Geologic provinces of Oklahoma: Oklahoma Geological Survey.

Thorman, C. H., and M.H. Hibpshman, 1979, Status of mineral resource information for the Osage Indian Reservation, Oklahoma :Administrative Report **BIA-47**: U.S. Geological Survey and Bureau of Mines.

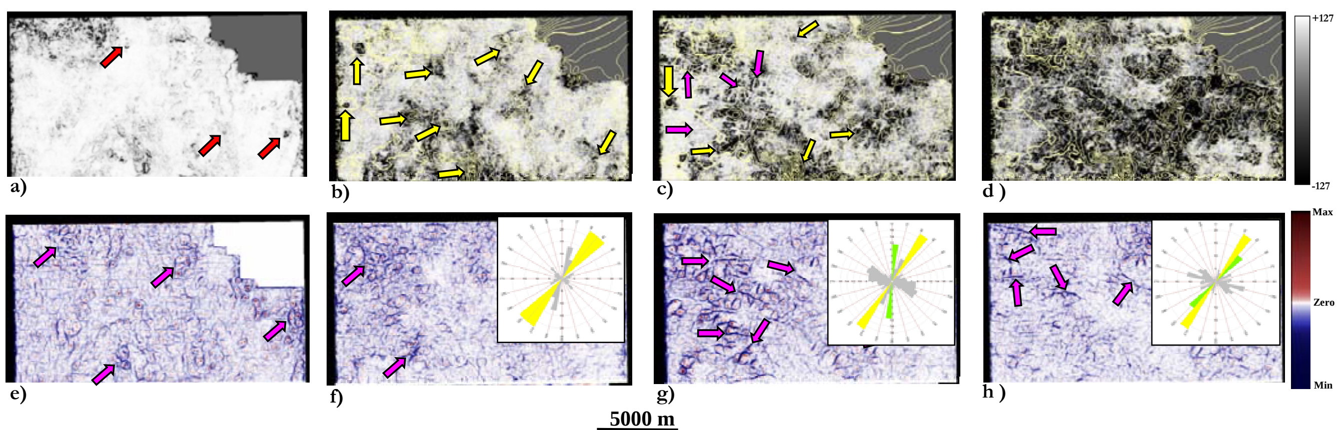


Figure 4. Coherence and Most-negative curvature (a), (e) along Mississippi Chert, (b), (f) top Arbuckle Group, (c), (g) below Arbuckle Chert and (d), (h) near Reagan Sandstone with overlain time-structure contour. Red arrows indicate the location of collapse features, magenta arrows indicate networks of fracture lineaments enhanced by curvature attributes, and yellow arrows indicate low coherence features that spatially correlate with structurally high areas. Inset rose diagrams show lineaments orientation and density, which increases below Arbuckle Group. Toward the Reagan sandstone and the basement, the density of the northwest trending lineaments diminishes.

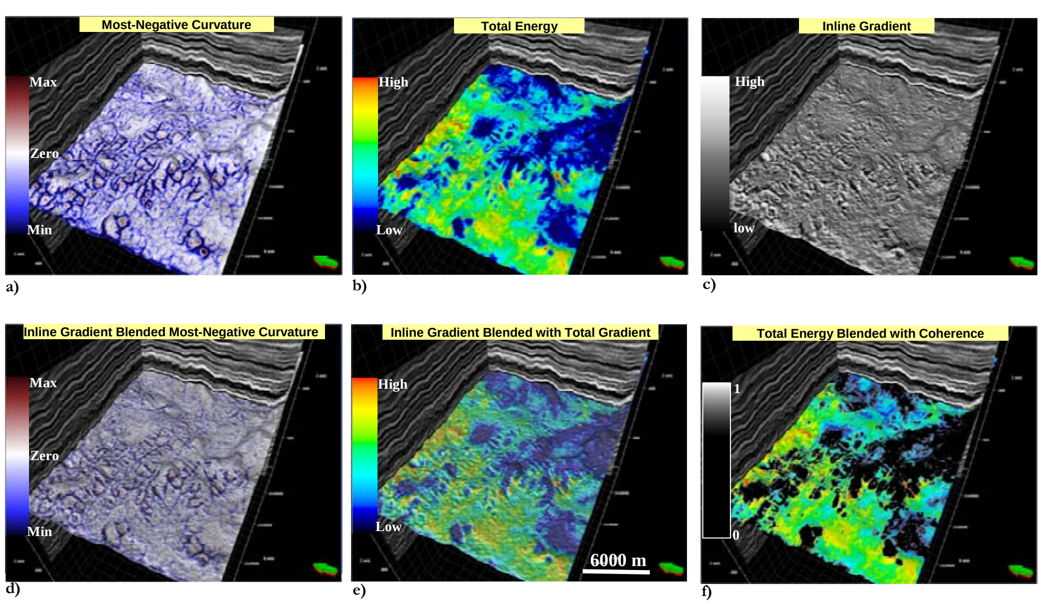
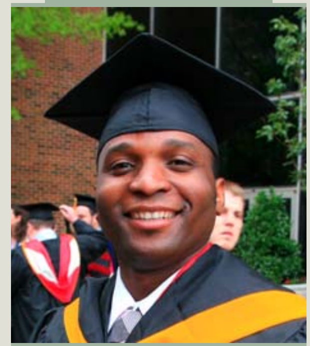


Figure 5. Co-rendering most-negative curvature (a), total energy (b) and coherence (Figure 4c) attributes with inline gradient attribute (c). Results of (a), (b), and (Figure 4c) is shown in (d), (e), and (f). Lineaments appears to be polygonal, highly coherent, and have a high total energy.

SUMMARY

In recent years, 3D volumetric attributes have gained wide acceptance by geoscience interpreters. The early introduction of single-trace complex trace attributes was quickly followed by seismic sequence attribute mapping workflows. 3D geometric attributes such as coherence and curvature are also widely used. Most of these attributes correspond to a very simple easy-to-understand measures of a waveform or surface morphology. However, not all geologic features can be so easily quantified. For this reason, simple statistical measures of the seismic waveform such as RMS amplitude prove to be quite valuable in delineating more chaotic stratigraphy. In this paper, we show how modern texture analysis based on the gray-level co-occurrence matrix, when coupled with recent developments in self-organizing maps clustering technology, extends such statistical measures to delineate features that geoscientists can see, but not easily describe.



Integrated Seismic Texture Segmentation and Clustering Analysis to Improved Delineation of Reservoir Geometry

Sipuikinene Miguel Angelo, Marcilio Matos, Kurt J. Marfurt. ConocoPhillips School of Geology & Geophysics*

INTRODUCTION

One of the goals of the seismic interpreter is to analyze seismic amplitude and phase character in order to predict lithologic facies and rock properties such as porosity and thickness. Seismic attribute analysis is a technique that is commonly used by the oil industry to delineate stratigraphic and structural features of interest. Seismic attributes are particularly important in allowing the interpreter to enhance and visualize subtle features at or below the limits of seismic resolution. For example, coherence can generate easy-to-understand images of polygonally faulted shales that may be difficult to see on seismic amplitude time slices. Curvature can enhance long wavelength (500 -1000 m) flexures and folds in and out of the plane. Spectral components may highlight thin bed tuning effects buried in the seismic waveform.

Each of these attributes is based on a very simple geometric or physical model that can be related to structure, stratigraphy, diagenesis, or data quality. However, not all geologic features follow such a simple model. Experienced interpreters can easily recognize the seismic response of crystalline basement, mass transport complexes, and carbonate reef buildups. But when put to the task they find it difficult to quantitatively define how they do their interpretation. Such interpreters (and human beings in general) are experts at texture analysis. Our study focuses upon seismic texture analysis, borrowing upon techniques commonly used in remote sensing to map terrain, vegetation, and land-use information. Textures are frequently characterized as different patterns in the underlying data. Seismic texture analysis was first introduced by Love and Simaan (1984) to extract patterns of common seismic signal character. Recently, several workers (West et al., 2002; Gao, 2003; Chopra and Alexeev, 2005) have extended this technique to 3D seismic data through the use of the gray-level co-occurrence matrix (GLCM). GLCM allows the recognition of patterns significantly more complex than simple edges. GLCM-based texture attributes are able to delineate complicated geological features such as mass transport complexes and amalgamated channels that exhibit a distinct spatial pattern.

What is Texture?

Texture is an everyday term relating to touch that includes such concepts as rough, silky, and bumpy. When a texture is rough to the touch, the surface exhibits sharp differences in elevation within the space of your fingertip. In contrast, silky textures exhibit very small differences in elevation. Seismic textures work in the same way, except elevation is replaced by brightness values (also called gray levels). Instead of probing a finger over the surface, a "window" or a square box defining the size of the area is used (Mryka, 2007).

The Gray Level Co-Occurrence Matrix

GLCM is a tabulation of how often different combinations of voxel brightness values (gray levels) occur in a sub-image window. The Grey Level Co-occurrence Matrix introduced by Haralick et al. (1983) has been applied by Reed and Hussong (1989), Gao et al. (2002), and Gao (2003) to 3D seismic data in order to quantify seismic stratigraphic textures. Intuitively, we mentally apply texture analysis any time we view a shaded-relief time-structure map. We recognize piecewise-smooth surfaces separated by discrete faults, tightly folded areas, incised dendritic channels, and chaotic zones. Our method differs from others in that it is structure-oriented and can therefore be applied to structurally complex 3D seismic volumes. Given that the seismic wavelet modulates the reflection coefficients and hence the subsurface lithology, we feel that measures such as spectral decomposition do an excellent job of measuring amplitude variability normal to the locally dipping plane. Parallel to the local dip, we define a local analysis window. We also reformat the data from 32-bit data to 65 integer gray levels (with values 1-32 correlating to troughs, 33 to a zero-crossing, and 34-65 to peaks), constituting a "quantization" step. We compute the GLCM within a $(2m_x+1)$ by $(2m_y+1)$ window:

$$M_{ij} = \sum_{p=-m_x}^{+m_x} \sum_{q=-m_y}^{+m_y} \delta(d_{pq} - i)\delta(d_{p+\Delta p, q+\Delta q} - j) \tag{1}$$

where d_{pq} and d_{pq} are the integer-valued scaled seismic data at the (p,q) and $(p+\Delta p,q+\Delta q)$ CDP locations and the delta function, $\delta(\xi)=1$ if $\xi=0$ and 0 otherwise. We choose a suite of offsets Δp and Δq to represent repetitive patterns at angles of $0^0,45^0,90^0,135^0$ to the acquisition axes. Since our input seismic (volumetric dip magnitude, or other attribute) data have been scaled to be integers between 1 and 65, our function M_{ij} can be written as a 65 by 65 matrix, **M**. Haralick et al. (1973) suggested 14 statistical measurements to describe a GLCM created from a moving window. Gao (2003) has added a few more. In this study, we use the four most-commonly used measurements of energy, E, contrast, C, homogeneity, H, and entropy, S.

$$C = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} M_{ij}(i-j)^2, \quad H = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} \frac{M_{ij}}{1+(i-j)^2}$$

$$S = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} M_{ij}(\ln M_{ij}), \quad E = \sqrt{\sum_{i=0}^{N-1}\sum_{j=0}^{N-1} M_{ij}^{\ 2}} \tag{2}$$

where N denotes the number of gray levels (in our case 65), and i and j are the rows and columns of the matrix **M**.

Summarizing, we need to define four items to use the GLCM:

- the quantization level of the image,
- the size of the moving window,
- the direction and distance of voxel pairs, and
- the statistics used as a texture attribute.

Given these four parameters, texture images can be extracted using along local dip and azimuth and used as features for direct interpretation or subsequent multi-attribute classifica–tion.

GLCM Workflow

Our 3D workflow is described by the flow chart shown in **Figure 1.** First, we pre-compute dip and azimuth at every seismic sample using one of several alternative 3D volumetric dip calculation algorithms. For reservoir studies, a sequence of stratal slices may be more appropriate. Next, we extract a $(2m_x+1)$ by $(2m_y+1)$ window of data for each and every output location. We then construct the GLCM using equation 1, followed by one or more attributes using equation 2. Finally we cluster these attributes using self-organizing maps for further interpretational analysis.

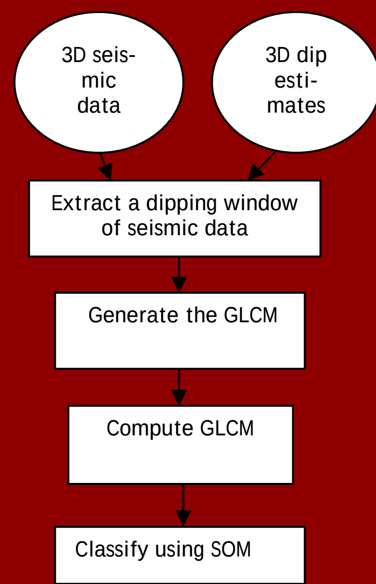


Figure 1. *The 3D GLCM workflow*

Self-Organizing Map (SOM)

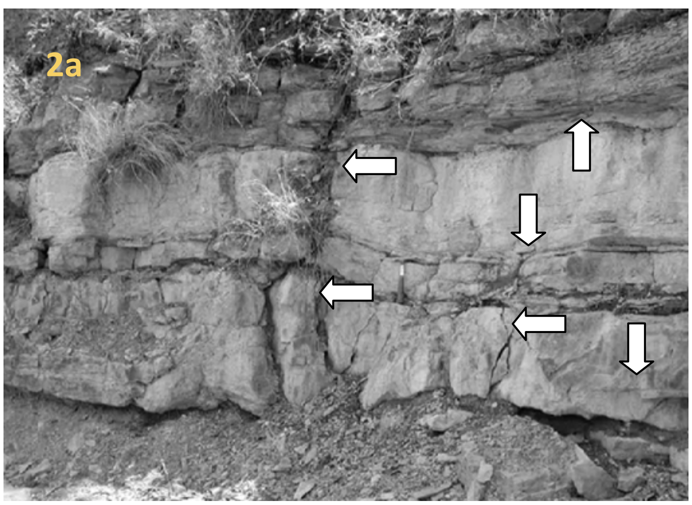
Self organizing maps, SOM, (Kohonen, 2001) and K-means clustering are the two most commonly used tools for non-supervised seismic facies analysis with SOM providing ordered clusters that can be mapped to a gradational color bar (Coléou et al., 2003). However, SOM can be interpreted as a mapping of the input n-dimensional input seismic attributes space on a two-dimensional grid that preserves the original topological structure. Since seismic data measures the lateral changes in geology, SOM preserves the topological relation of the underlying geology (Matos et al., 2007). In this paper, we assumed that the input variables to the SOM are the GLCM attributes and the resulting 2D SOM is colored against a 2D colorbar (Matos et al., 2009).

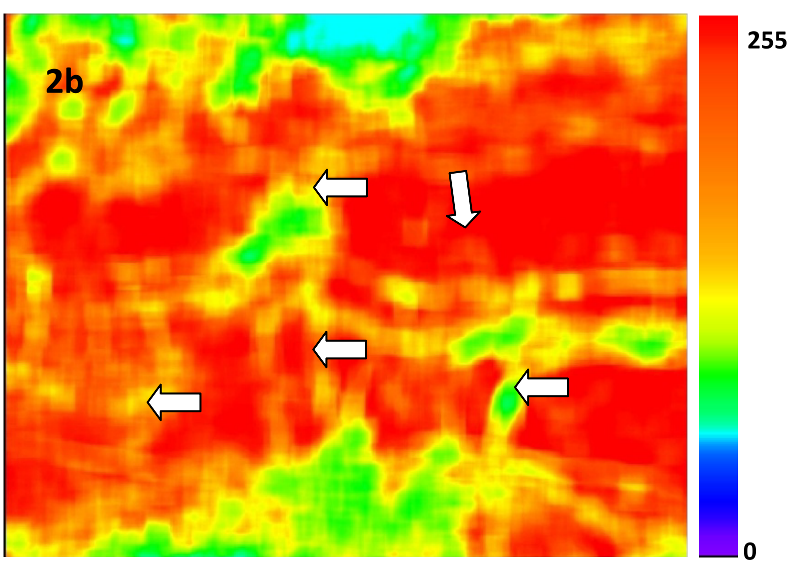
Application to a Photographic Image of an Outcrop

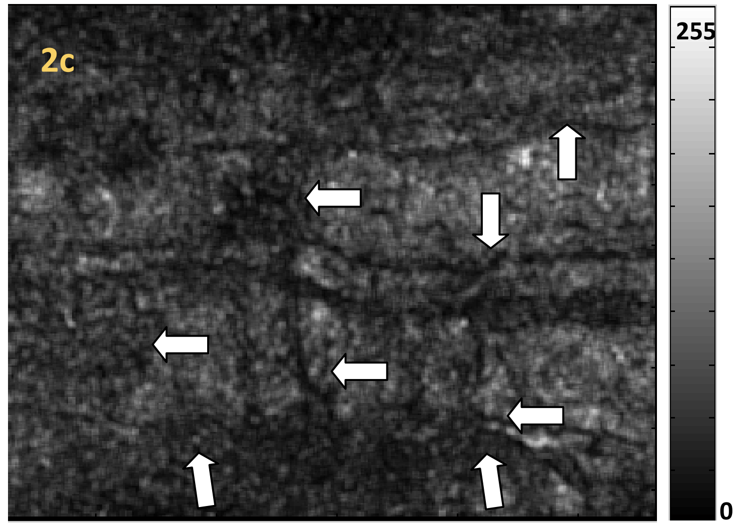
To demonstrate how GLCM techniques are applied to remote sensing data, we apply it to a photographic image of the outcrop shown in **Figure1** which shows fine-grained clay-rich limestones that occur in beds up to two feet thick with intervening shale layers. The photographic image size is 424 by 556 pixels, and is quantized into 256 gray levels. We used an 11 by 11 running window of ($m_x=m_y=5$) and computed matrices **M** and texture attributes at $0^0,45^0,90^0,135^0$. After principal component analysis (PCA) of the collected texture images, PC components representing more than 99% of information were extracted for classification. **Figures 2c and d**, indicate that certain attributes show distinct features compared to other attributes. After applying SOM, **(Figure 2b)** the fine-grained clay-rich limestones and the intervening shale layers were distinctly separated by the assigned quantization level.

Application to 3D Seismic Data

Given this visual calibration we turn our attention to a 3D seismic survey acquired in Osage County, OK, where our goal is to map subtle, thin-bed channels that form economic gas and oil reservoirs. The resulting texture and SOM analysis provides a clearer picture of the distribution, volume, and connectivity of the hydrocarbon-bearing facies in a reservoir facies known to have sand channels. **Figure 3a** shows a horizon slice taken at 20ms below Oswego horizon through the seismic amplitude data. **Figures 3b and c** show the final 2D SOM and corresponding 2D color bar. **Figures 3d and e** show two representative, complementary, GLCM attributes - contrast and energy. These latter contrast and energy images have high amplitude values within the channel and intermediate values in what we interpret to be the channel levee.







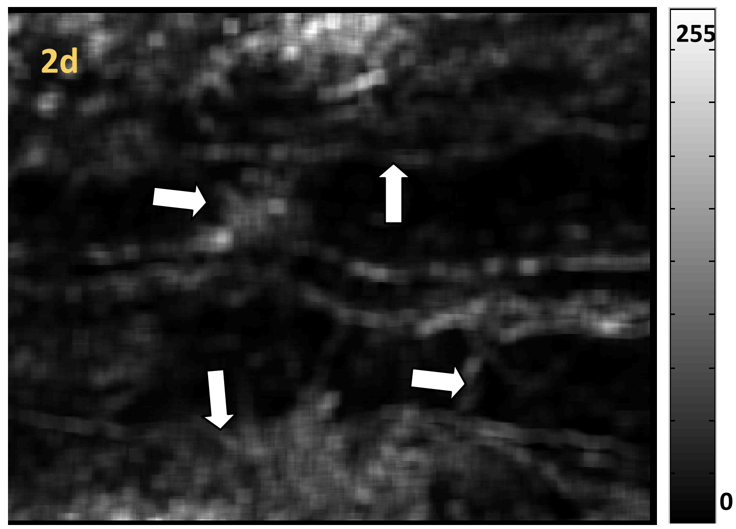


Figure 2. (a) Photo of an outcrop image of Monongahela Group, Pittsburgh Formation (from www.geology.pitt.edu).

Block white arrows indicate texture characteristics expected to be seen after applying the GLCM and the SOM analysis. **(b)** Corresponding SOM 1D and GLCM **(c)** homogeneity 90^0, and **(d)** contrast attributes 90^0.

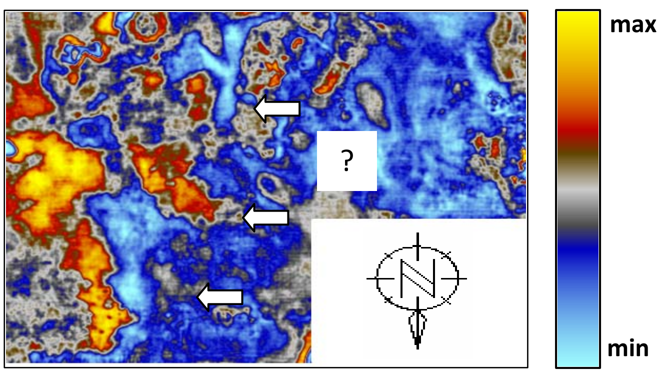
Conclusion

2D seismic stratigraphy is based on human interpreter identification of subtle textures, such as onlap, offlap, unconformities, hummocky clinoforms, and parallelism. With the aid of attributes, 3D seismic geomorphology extends these concepts to volumetric data. GLCM technology is a preliminary attempt at quantifying these relationships for further analysis using computer vision. Texture attributes hold significant promise in quantifying geological features such as mass com–plex transport, amalgamated channels, and dewatering features that exhibit a distinct lateral pattern beyond simple edges.

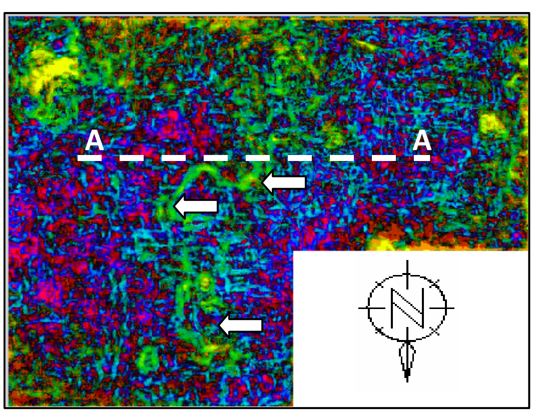
Acknowledgements

Thanks to the Osage Nation for providing a license to the seismic data volume used in this paper. Thanks also to the industry sponsors of the OU Attribute-Assisted Seismic Processing and Interpretation (AASPI) consortium. We also would like to thank our colleagues Kui Zhang , Brad Wallet, Tim Kwiatkowski and Ha Mai for their input.

3a



3b



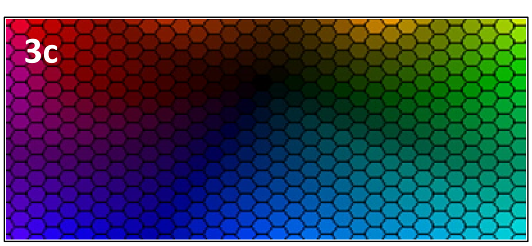
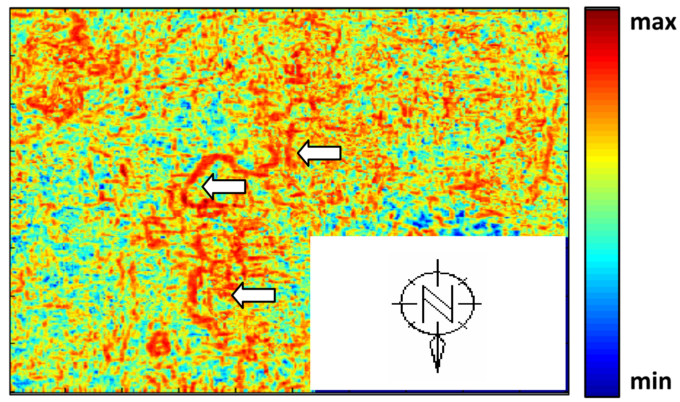
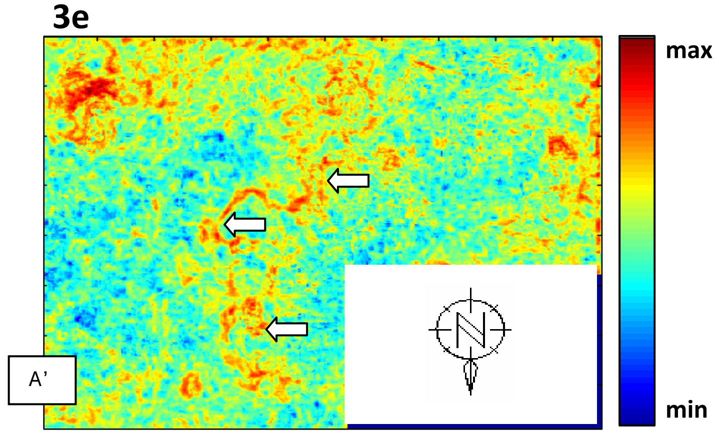


Figure 3. (a) Horizon slice 20ms below the Oswego horizon showing a suspected channel. Block white arrow indicates a channel-levee complex. **(b)** SOM clusters computed using GLCM contrast, and energy attributes computed at 0, 45, 90, and 135 degrees with offests Δp, Δq = 0 or 1, **(c)** 2D SOM 256-class topology mapped against a 2D 256- colorbar. Horizon slices through representative GLCM **(d)** contrast and **(e)** energy attribute volumes indicating the channel levee complex. **(f)** Vertical slice AA' through the seismic amplitude volume showing the channel.

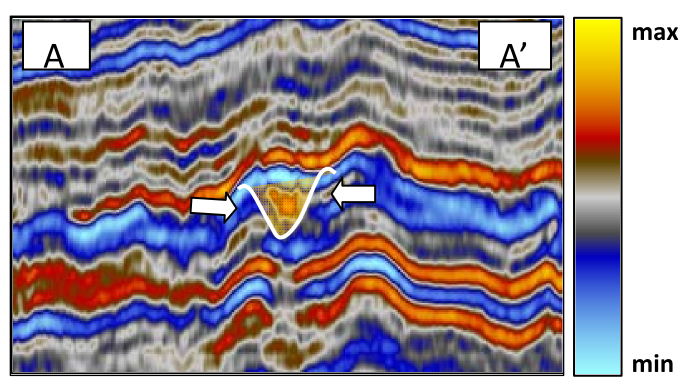
3d



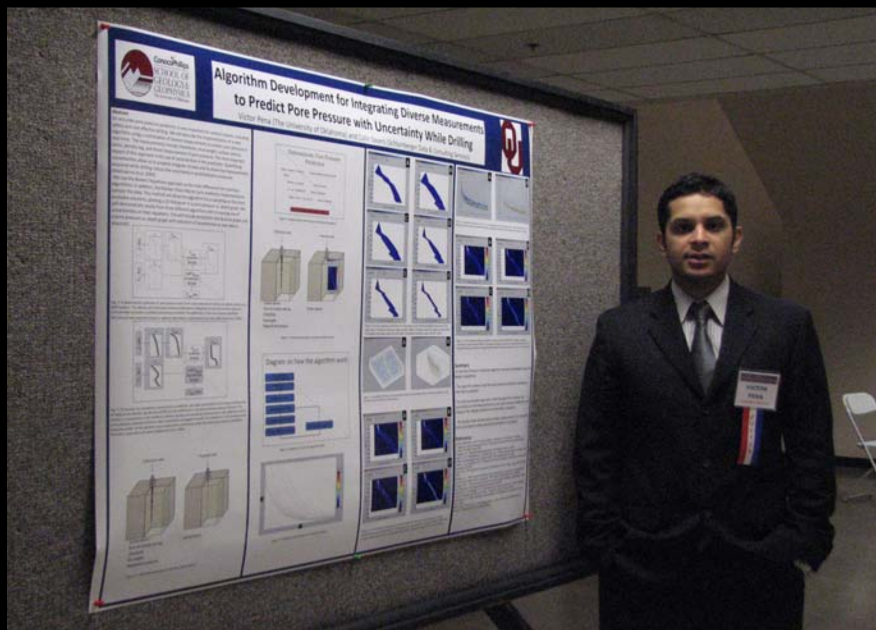
3e



3f



Algorithm Development for Integrating Diverse Measurements to Predict Pore Pressure with Uncertainties While Drilling



Victor Pena, *University of Oklahoma, and* ***Colin Sayers***, *(Schlumberger Data & Consulting Services)*

ABSTRACT

An accurate pore pressure prediction is very important for several reasons, including safety and cost effective drilling. We define the implementation of a new algorithm using a combination of diverse measurements to predict pore pressure in real time. The measurements include checkshots, mud weight, surface seismic, sonic, density log, and direct measurement of pore pressure. The more important aspect of this approach is the use of uncertainties in the prediction. Quantifying uncertainties allow us to properly integrate all data and to show how measurements acquired while drilling reduce the uncertainty in predicted pore pressures (Malinverno et al. 2004).

We use the Bower's equations approach as the main difference from previous algorithms. In addition, the Markov Chain Monte Carlo method is implemented to sample the data. This method will allow the algorithm focus sampling on the more probable solutions, plotting a 2D histogram in a pore pressure vs. depth graph. We obtained results from three different algorithms with increasing use of uncertainties in their equations. This includes probability distributions graph and pore pressure vs. depth graph with reduction of uncertainties as new data is acquired.

The OGS Booch Field Trip — Return to the Arkoma Basin

Neil H. Suneson and Dan T. Boyd, *Oklahoma Geological Survey*

After several years away from southeastern Oklahoma, the Oklahoma Geological Survey returned to the Arkoma Basin. Led by Survey geologists Neil Suneson, Dan Boyd, and Rick Andrews, a group of about 20 petroleum professionals from throughout Oklahoma visited 11 key outcrops of the Desmoinesian Booch sandstone. The Booch is not only a prolific natural gas producer in a number of important fields in the Arkoma Basin, but it also produces oil on the Cherokee Shelf to the north. Although rarely the primary target for Oklahoma operators, the Booch can be a "bail-out" zone for wells targeting either the underlying Hartshorne sandstone or Hartshorne coal. Gas in the Booch is typically commingled with Hartshorne gas.

The field trip visited the best stops described in OGS Guidebook 35 written by Suneson and Boyd. The trip allowed participants to examine different sedimentary facies of Booch channel-fills and deltas and relate these to subsurface well-log signatures, environment of deposition, and productivity using gamma-ray profiles recorded at the surface. It also showed how the various Booch sandstones can be separated by placing them into a sequence-stratigraphic framework. Given the State's confusing subsurface nomenclature, this is important for tracing genetically related sandstone packages throughout the Arkoma Basin. In addition, Boyd's work elsewhere in Oklahoma shows that many of the characteristics of the Booch deltas are identical to those of numerous other productive Pennsylvanian reservoir systems throughout the State. Because the Booch crops out in the Arkoma Basin (in many cases short distances from where it produces in the subsurface) it enables geologists to create a mental image of the sandstone reservoir that they are producing.

The field trip began the morning of March 5, 2009 in McAlester. The first three stops included a channel-fill sandstone in the Cameron Sandstone (Booch parasequence (PS) -1) near Blanco, a delta-plain sequence in the Warner Sandstone (PS-3/3A) including two coals near Haileyville (Fig. 1), and a tidally influenced distributary-mouth bar (Cameron Sandstone (PS-1)) near Adamson. Discussions focused on the detailed measured sections, exposed sedimentary structures, gamma-ray profiles of the outcrops, and comparisons with nearby well-logs. These three stops served as an excellent introduction to the variety of depositional settings that we would see during the rest of the two-day field trip.

Figure 1. *Geologists examining the base of the Warner sandstone at the Haileyville railroad outcrop. A thick section of dark-gray marine shale is well-exposed below the sandstone, and the contact between the shale and sandstone is abrupt and erosional. The geologists are looking at what appear to be channelform features at the base of the sandstone.*

Figure 2. *Neil Suneson (pointing at map) and Dan Boyd (holding left side of map) locating Howe outcrop. The ridge behind the vans is underlain by the Warner sandstone which here exposes a distributary channel overlying fine-grained marine bar strata.*

At midday we stopped to look at the underlying Hartshorne Formation between the towns of Panola and Red Oak. Here, the Hartshorne rapidly changes from a well-stratified, sandstone-poor marine-bar facies to a massive, cliff-forming incised-valley-fill sandstone 80 feet thick. After hiking through the woods, losing no one, some of us crawled down the cliff face to see the lower part of the sandstone, while others admired the view of the Ouachita frontal belt to the south from the top of the cliff.

After an all-you-can-bear-to-eat buffet lunch in Red Oak, we continued east, examining another outcrop of marine-bar strata capped by a distributary-channel sandstone near the town of Howe (Fig. 2). After driving through Poteau and past the AES Shady Point power plant, we examined a somewhat enigmatic outcrop of the Lequire Sandstone (PS-2) just south of the town of Spiro. Here, a thick section of dark-gray marine shale underlies well-stratified sandstone with distinct marine characteristics, including a variety of trace fossils. However, the contact between the shale and sandstone is abrupt and erosional, suggesting some channeling.

The last stop of the day was at another outcrop of the Warner Sandstone (PS-3/3A) at the dam below New Spiro Lake. Here, two coarsening-upward distributary-mouth-bar sequences show clear evidence for tidal reworking.

Dinner, overnight accommodations, and breakfast the next morning were graciously provided by the Robert S. Kerr Conference Center, located on a bluff of Savanna Sandstone looking south over a ridge-and-valley setting. Appropriately, this area is dominated by the McAlester Formation and its Booch sandstones – the focus of our attention.

Day two began with two outcrops along the same Warner Sandstone ridge that we visited at the last stop the previous day. The first outcrop was a railroad cut near the town of Panama where a marine shale is overlain by two coarsening-upward sequences that are separated by an angular unconformity. The upper sequence shows repetitive, cyclic beds about 6 inches thick which are interpreted as evidence for tidal reworking. Shale drapes and flaser bedding support the interpretation that this outcrop (like many other Booch outcrops) is a tidally influenced distributary-mouth bar. The second stop was a few miles west at an outcrop near Carter Lake. Here, we observed a sequence of marine shales grading upward into marine-bar strata that are abruptly overlain by a distributary channel (Fig. 3).

The next outcrop, identified as the Campground Spring Mountain stop by Suneson and Boyd (2008), shows a petroleum geologist's dream reservoir – an incised-valley sandstone. This Booch sandstone consists of more than 100 feet of medium-grained, unstratified, porous sandstone - undoubtedly a series of nested channel deposits filling an incised valley. Similar valley-fill deposits have created the most prolific petroleum reservoirs in the State not only in the Booch but throughout much of the Pennsylvanian-Permian stratigraphic interval. Although the environment of deposition of this sandstone is known, its precise placement within the Booch is not. The base of the sandstone is only 175 feet above the Hartshorne coal (easily identified by the strip mines), which, barring some sort of structural discontinuity, would place it within the lower Booch (PS-5 or 6). However, there are no lower Booch incised-valley-fill sandstones identified anywhere in the Arkoma Basin. In environment and thickness, this outcrop closely resembles the middle Booch Warner (PS-3/3A) incised-valley sandstone that has been logged in the subsurface by nearby wells. However, the Warner appears to crop out as a continuous sandstone ledge that is stratigraphically above this outcrop. This is a problem that the authors are leaving to future geologists.

Figure 3. *Booch field-trip participants at the Carter Lake outcrop. A thick section of well-exposed shale is at the base of the outcrop. The shale grades upward into interbedded shale and siltstone (near-vertical face forming most of cliff) which is capped by a thick-bedded sandstone with large-scale cross-beds. The sandstone is interpreted as a distributary channel.*

After a short drive on some back roads south of Keota and then west on Highway 9, we stopped at well-exposed channel sequence in what is mapped as Warner-Lequire. The coarse grain size of the sandstone and large-scale cross stratification identify this as a high-energy fluvial deposit.

The final stop of the trip, which for many of us was our favorite, was an extremely well-exposed delta-plain sequence in the overlying Savanna Formation located just south of the town of Lequire. The roadcut here, which is one of the best outcrops in Oklahoma, exposes repeated fining-upward sequences of crevasse-splay sandstones overlain by interdistributary bay-fill shales (Fig. 4). We spent a relaxing hour examining carbonized tree trunks, coal beds, soft-sediment deformation features, and collecting plant fossils. After this we headed back to McAlester for a rendevous with our cars and home.

The field trip was an excellent complement to Boyd's study of the sequence stratigraphy of the Booch sandstones (Boyd, 2005). In addition, the guidebook is the latest in a series of OGS guidebooks on the structure and stratigraphy of the Ouachita Mountains and the southern part of the Arkoma Basin (e.g., Suneson and others, 2005). The weather was perfect and the camaraderie and discussions even better. All agreed that it was good to be back in the field looking at rocks and talking about how much better Oklahoma's fluvial-deltaic petroleum reservoirs can be understood after seeing the Booch.

Figure 4. *Lower part of the Lequire outcrop. A series of fining-upward sequences is exposed in this part of the Savanna Formation. Here, the basal sandstone of one of those sequences overlies with an abrupt contact interdistributary bay-fill shales. The base of the sandstone contains numerous large upright (in situ) carbonized tree trucks (probably lycopods). The sandstone grades up into interbedded siltstone and sandstone, which grades up into shale and minor siltstone and coal.*

References Cited

Boyd, D.T., 2005, The Booch gas play in southeastern Oklahoma: regional and field-specific petroleum geological analysis: Oklahoma Geological Survey Special Publication 2005-1, 91p.

Suneson, N.H.; and Boyd, D.T., 2008, Guidebook to the Booch sandstones: surface to subsurface correlations: Oklahoma Geological Survey Guidebook 35, 96p.

Suneson, N.H.; Çemen, Ibrahim; Kerr, D.R.; Roberts, M.T.; Slatt, R.M.; and Stone, C.G., 2005, Stratigraphy and structural evolution of the Ouachita Mountains and Arkoma Basin, southeastern Oklahoma and west-central Arkansas: applications to petroleum exploration: Oklahoma Geological Survey Guidebook 34, 128p.

Geochemical Characterization of Ghungro-1 Oil Well from Lower Indus Basin of Pakistan

Abdus Saleem[a,b], **Richard Paul Philp**[b], **Fazeelat Tahira**[a]

Chemistry Department, University of Engineering and Technology, Lahore-Pakistan[a]

ConocoPhillips School of Geology and Geophysics, University of Oklahoma[b]

ABSTRACT

This paper is an attempt to interpret data that support the belief that hydrocarbon discoveries in Pakistan are world class. Only few previously published papers have discussed the source potential of oil wells in Lower Indus Basin of Pakistan. In this paper, well cuttings (12) and the crude oil from Ghungro-1 oil well have been investigated. Total organic carbon (TOC) and vitrinite reflectance (R_0) of oil well cuttings were determined by Humble Geochemical Services. API gravity and sulfur content of the crude oil were determined by using ASTM standard methods. The oil sample was deasphalted using an alumina adsorption method. One aliquot of the maltene fraction was fractionated into saturates, aromatics and resins using HPLC and the saturate fraction was analyzed by HTGC. The second aliquot of maltenes was used for precipitation of the wax fraction using a modification of the method described by Burger. TOC varies from top to bottom in the oil well and has maximum value at Talhar Shale. R_0 (0.42-1.14%) increases from top to bottom with slight variations. Maturity of the source rock samples was also investigated using biomarkers derived from GC- and GC-MS techniques. API gravity, sulfur and wax content were determined to characterize the crude oil and HTGC analysis of the saturate fraction of crude oil shows that it was not biodegraded.

INTRODUCTION

A suite of cuttings from the Ghungro-1 well located in Lower Indus Basin, Sindh Province, Pakistan was evaluated using various geochemical methods. The Sembar Formation has been identified as the primary source rock for much of the Indus basin, but other known potential source rocks are also present. Of all the possible source rocks in the Lower Indus Basin, the Sembar is the most likely source rock for the largest portion of the produced oil and gas (Wandrey et al., 2004). Sembar

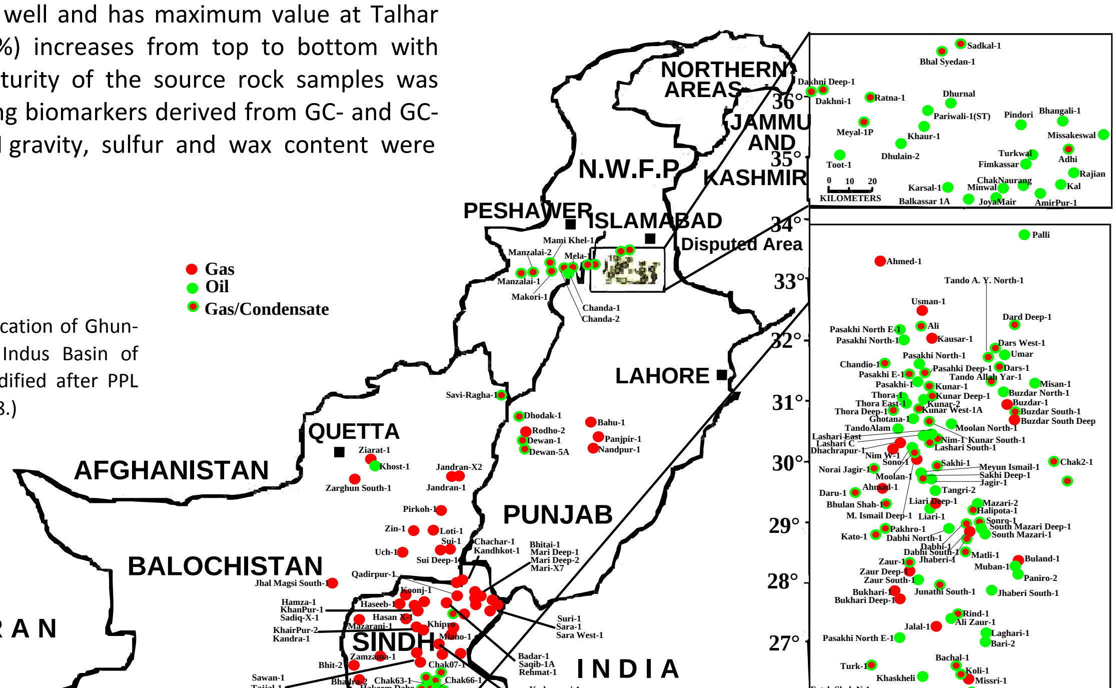


Figure 1: Map showing location of Ghungro-1 oil well in Lower Indus Basin of Pakistan. (Figure was modified after PPL exploration, Pakistan, 2008.)

Formation (Lower Cretaceous age) consists mainly of shale with subordinate amounts of siltstone and sandstone. The Sembar was deposited over most of the Indus Basin under marine conditions and ranges in thickness from 0 to 260 meters (Iqbal and Shah, 1980). The Lower Goru Formation lies above the Sembar, and splits into a lower unit of sandstones and an upper unit consisting mostly of shales and marls (Dolan, 1990). Source rocks are mainly Sembar shales (Early Cretaceous) which were deposited during rifting. The Goru sands, which are the main producing reservoirs, overlie the source beds (Ahmed et al., 1994).

Location of Ghungro-1 oil well

Ghungro-1 oil well (**Figure 1)** is located in Lower Indus Basin of Pakistan. The latitude and longitude of this well are 24° 23' 29.1" N and 68° 35' 53.97" E respectively. Total depth is 12,135 ft. that penetrates into the Chiltan Formation of Jurassic age.

EXPERIMENTAL

TOC and R_0 of oil well cuttings

Oil well cuttings (12) were washed, dried, pulverized and passed through a 40 mesh sieve. These samples were sent to Humble Geochemical Services, Weatherford Laboratories (TX, USA) for TOC and R_0 determination.

API gravity and sulfur content of crude oil

API gravity and sulfur content were determined following ASTM (D287) and IP (63) standard methods. Details of procedures have been described previously (Fazeelat and Saleem, 2007).

Removal of Asphaltenes

In this study complete removal of asphaltenes was assured using alumina adsorption method developed by Thanh (1999) and subsequently modified by Hsieh (2000).

Wax precipitation

Wax was precipitated using the acetone precipitation method of Burger (1981). Maltene fractions were weighed (1g) into a tared bottle and petroleum ether (7ml) was added with stirring until the sample dissolved. About 22ml of acetone was added, stirred, and placed into a deep freeze at -21°C overnight. Buchner porcelain filtering funnel, whatman No. 934 glass micro fiber filters, vacuum flask and a mixture of three parts acetone plus one part ether were also precooled to the same temperature. The sample was filtered by pouring it slowly onto the stirring rod as a guide. The stirring rod, bottle, and filter cake, were washed well with the cold solvent mixture. The filter cake wax was transferred to a washed and cleaned glass bottle. Solvent was evaporated to dryness, quantified, and percentage was calculated.

Fractionation of Maltene

An aliquot of the maltene fraction was fractionated into saturates, aromatics and resins. The maltene fraction (20mg) was dissolved into 50µL of hexane and injected into HPLC (HP 1050). The saturate fraction was eluted with hexane, aromatics with dichloromethane and resins with ethyl acetate. Additionally, the elution of the aromatic and resin fraction was monitored with a Kratos UV Spectroflow 783 set at λ=254nm. The saturate faction was quantified and prepared for HTGC analysis.

High Temperature Gas Chromatography

The saturate fraction was analyzed using a Carlo Erba GC8000 high temperature gas chromatograph, equipped with an on-column injector and a J&W scientific DB-1 HT fused silica capillary column (30m x 0.32mm i.d. x 0.1µm film). The oven temperature was programmed from 60 to 400°C at a rate of 4°C/min, with flame ionization detector (FID) temperature set at 400°C (total run-time of 100 min). Helium was used as carrier gas at a flow rate of 2ml/min.

RESULTS AND DISCUSSION

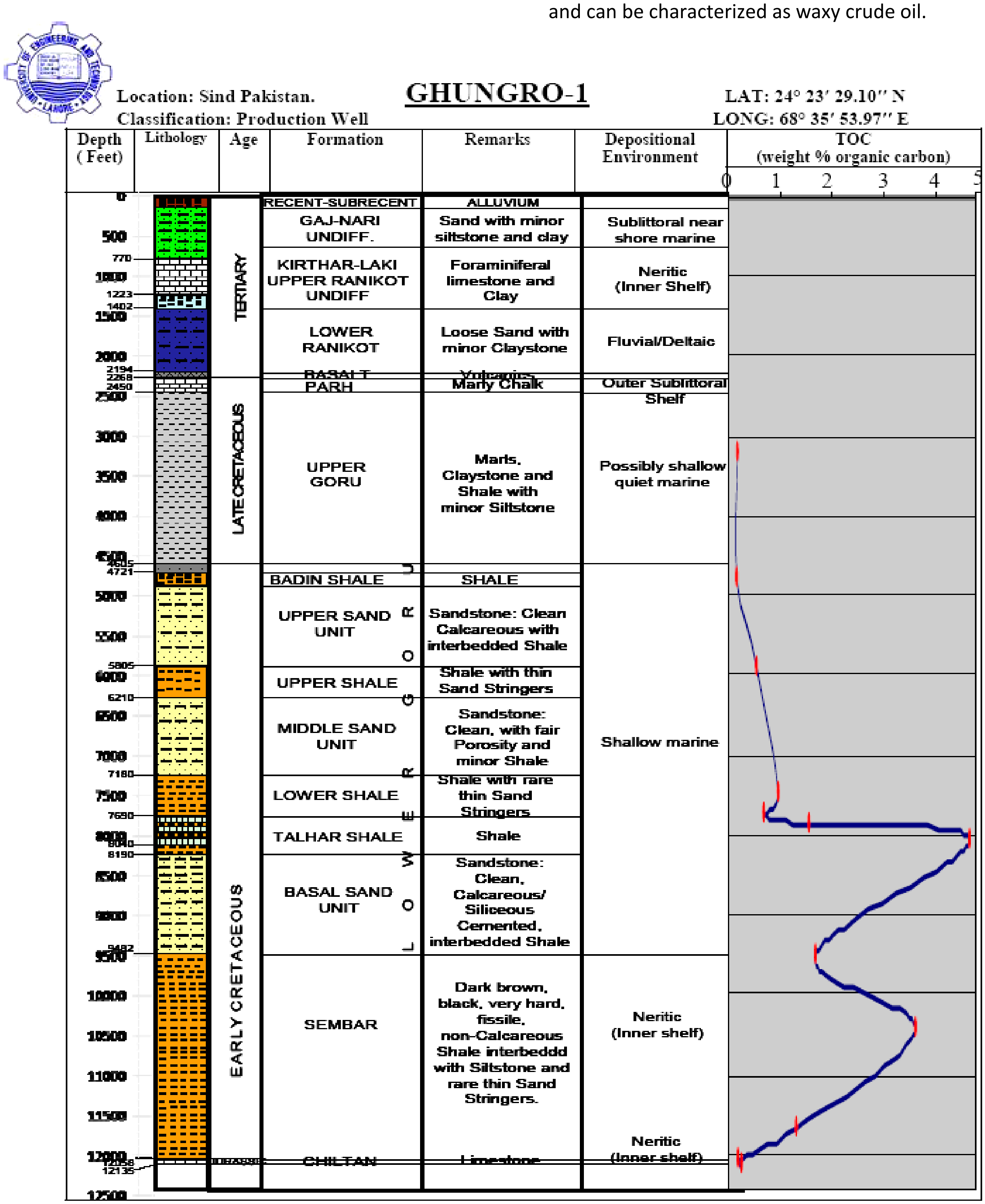
Table 1: Total organic carbon of oil well cuttings from Ghungro-1 oil well

Sr. No	Depths of oil well (feet)	TOC* Wt%	Calculated %R_0*
1	3245	0.18	2.52
2	4765	0.17	0.42
3	5925	0.56	0.63
4	7505	0.97	0.74
5	7765	0.69	0.62
6	7885	1.56	0.74
7	8105	4.64	0.76
8	9505	1.69	0.81
9	10455	3.60	1.01
10	11655	1.32	0.42
11	12095	0.20	1.14
12	12125	0.26	0.65

*: **Results obtained from Humble Geochemical Services.**

The TOC of the 12 samples from the Ghungro-1 oil well in Lower Indus Basin ranges between 0.17-1.69% (**Table 1**) and maximizes at 8105 feet (4.64%) showing highest organic content at Talhar Shale (**Figure 2**). The TOC of source rock organic matter is poor at the top and becomes very good at 8105 feet and then again becomes poor at Chiltan Formation at 12125 feet (Peters and Moldowan, 1993). R_0 increases with depth showing slight variations in values with a minimum of 0.42% at the 4765 feet becomes 0.76% at 8105 feet and maximizes (1.01%) at 10455 feet. At higher maturities characteristic of the late oil window (R_0 (1.0-1.3%) generated products become lighter (high API gravity) with higher gas/oil ratios (Peters and Moldowan, 1993). Thermal maturity variations were also investigated through the use of biomarkers as determined by GC and GC-MS.

API gravity describes crude oil in the following manner: Light is greater than 31.1°API gravity; medium is 22.3 to 31.1°API; heavy is 10 to 22.3° API; and extra heavy is less than 10° API gravity (Martinez 1984; Hunt, 1996; Saleem and Fazeelat, 2007). Here API gravity of Ghungro-1 oil is 39.5° and is a light crude oil. Sulfur content is 0.1%, which is <0.5% and known as sweet crude oil (Peters et al., 2005). It has been reported (Hedberg, 1968; Fazeelat and Saleem, 2007) that crude oil having wax content more than 5% are high wax crude oils. Ghungro-1 crude oil has 15.51% wax (**Table 2**) and can be characterized as waxy crude oil.



Source: B.P. Pakistan, TOC values: Humble Geochemical Services, Weatherford Labs, TX, USA.

Figure 2. **Ghungro-1 oil well section showing stratigraphy, depositional environment and TOC.**

Table 2: Geological and physicochemical data of Ghungro—1 crude oil

Oil field	Total Depth* (feet)	Probable Age	API gravity @60°F	Sulfur content Wt (%)	Wax content Wt (%)
Ghungro-1	12135	Early Cretaceous	39.5	0.1	15.51

***: Data from British Petroleum, Pakistan**

HTGC analysis of saturate fraction of crude oil indicates a full suite of *n*-alkanes from C_{12} to more than C_{40} (**Figure 3**). The high API gravity and presence of full range *n*-alkanes indicate that Ghungro-1 oil is not biodegraded (Wegner et al., 2002).

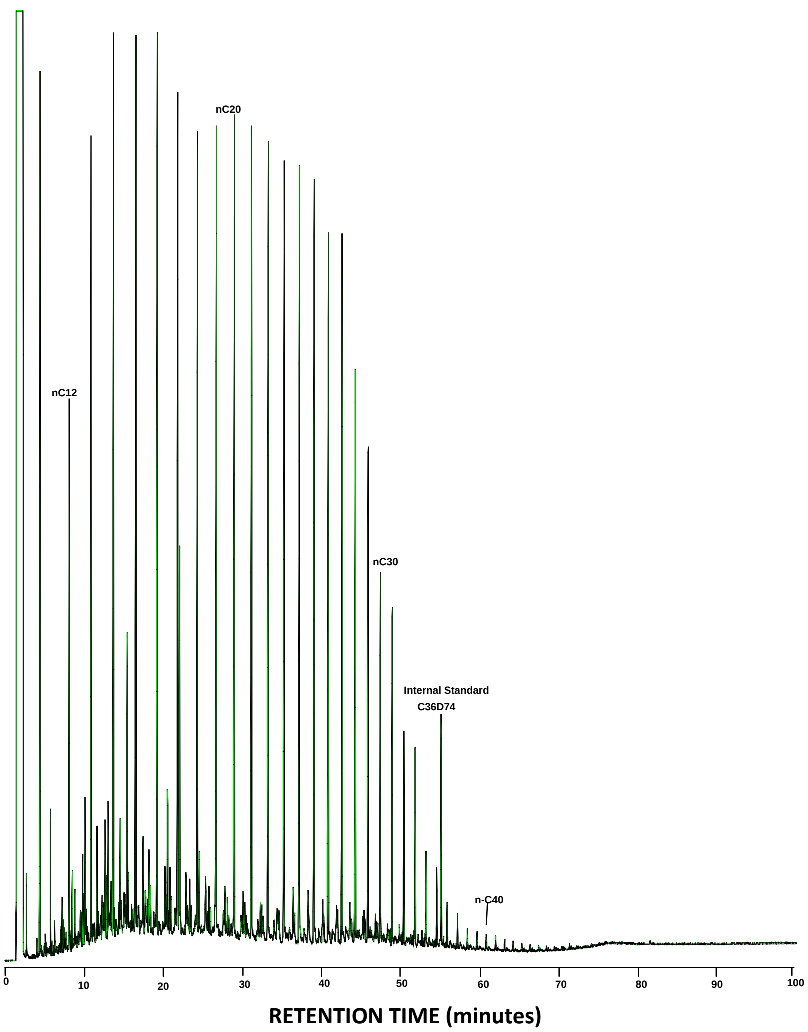


Figure 3: HTGC chromatogram of saturates fraction from Ghungro-1 crude oil

CONCLUSION

The oil well cutting of Sembar Formation show maximum TOC at Talhar Shale. The organic source potential is poor at the top and very good at Sembar Formation. Value of R_0 of Sembar Formation indicates its maturity would produce oil. Crude oil analysis reveals that Ghungro-1 is a light crude oil with low sulfur and high wax content and can be categorized as waxy crude oil. HTGC analysis of the saturate fraction of crude oil shows that it is not biodegraded.

REFERENCES

1. Ahmed, R. Ali, S. M. and Ahmad, J. Review of petroleum occurrence and prospects of Pakistan with special reference to adjoining basins of India, Afghanistan and Iran; Petroleum Journal of Hydrocarbon Research, Hydrocarbon Development Institute of Pakistan, Islamabad, Pakistan, Volume 6, No. 1&2, 1994, p. 7-18.

2. Burger, E. D., Perkins, T. K. and Striegler, J. H. Studies of wax deposition in the Trans Alaska pipeline. Journal of Petroleum Technology, June, 33, 1981, p. 1075-1086.

3. Dolan, P. Pakistan: a history of petroleum exploration and future potential. In: Brooks, J. 9Ed.), Classic Petroleum provinces. Geol. Soc. (London) Special Publication No. 53, 1990, p. 503-524.

4. Fazeelat, T. and Saleem, A. GC-FID Analysis of Wax paraffins from Khaskheli Crude oil. Jour. Chem. Soc. Pak. Vol. 29, No.5, 2007 p. 492-499.

5. Hedberg, H. D. Significance of high-wax oils with respect to genesis of petroleum. AAPG Bulletin 1968, 52, p. 736-750.

6. Hsieh, M. Philp, R. P. and del Rio, J. C. Characterization of high molecular weight biomarkers in crude oils. Organic Geochemistry, 33, 2000, p. 1581-1588.

7. Hunt, J. M. Petroleum Geochemistry and Geology, 2nd ed.1996, p.52.

8. Iqbal, M. W. A. and Shah, S. M. I. A guide to the Stratigraphy of Pakistan. Geological Survey of Pakistan, Quetta, 53, 1980, p.34.

9. Martinez, A. R. Classification and nomenclature systems for petroleum and petroleum reserves. Proceedings of Eleventh World Petroleum Congress. Vol.2: Geology Exploration Reserves. Chichester; Wiley, 1984, p. 325-329.

10. Peters, K.E. and Moldowan, J.M. The Biomarker Guide, Interpreting Molecular Fossils in Petroleum and Ancient Sediments., Prentice Hall, 1993, p.133 and 217.

11. Peters, K. E., Walters, C. C., and Moldowan, J. M. The Biomarker Guide, Biomarkers and isotopes in petroleum exploration and earth history, 2nd ed. Vol. 2, 2005, p. 1025.

12. Thanh, N. X., Hsieh, M. and Philp, R. P. Waxes and asphaltenes in crude oils. Organic Geochemistry, 30, 1999, p. 119-132.

13. Wandrey, C. J., Law, B. E. and Shah, H. A. U.S. Geol. Surv. Bull., 2208-C, 13, 2004, p. 13

14. Wenger, L. M., Isaksen, G. H. Control of hydrocarbon seepage intensity on level of biodegradation in sea bottom sediments, Organic Geochemistry, 33, 2002, p. 1277-1292.

GEOL 6970 Class
Stacey Evans
Paul Bowen
Matthew Hamilton
Matthew Cleveland
Charles Baker

PEGMATITE FIELD TRIP

In the spring semester of 2009, our Pegmatite class taught by Dr. David London took a field trip to see pegmatites in the field and collect some samples. After plans to visit the TANCO mine in Canada and the Harding mine in New Mexico fell through, we opted for a trip to the Llano area of Texas. We only had one day in the field, but everyone saw some really awesome rocks and collected some great samples!

After a huge breakfast, we were off to the first site with our guide, Frank Roberts. At the Cactus Jack pegmatite, everyone was able to find several large samples of textbook graphic granite. The day started off cool and cloudy so we spent most of the morning at this site. A few people were lucky enough to find green beryl, and even a large monazite sample was recovered.

The next pegmatite we went to was the Petrick Pegmatite. This site is in an abandoned quarry, so there were excellent exposures of the pegmatite. Unfortunately for those who wished to collect samples, most were boulder-sized with dinner plate-sized blocky microcline crystals, and we couldn't take them with us. However, small samples of fluorite, biotite, and even one or two rare-earth minerals were easily found.

After a short stop at a roadcut with some much finer grained graphic granite and another where we were able to see pegmatite in contact with gneiss, we visited the Badu Hill pegmatite, which has undergone a high degree of late stage hydrothermal alteration. At this site, we were able to collect some dark purple fluorite, as well as several other minerals including sulfides and radioactive rare-earth minerals. We also found samples of a very unusual biotite-zircon intergrowth, as well as a small locality of hexagonal muscovite crystals embedded in a very friable rock which may have once been fine-grained graphic granite, but has been extensively altered.

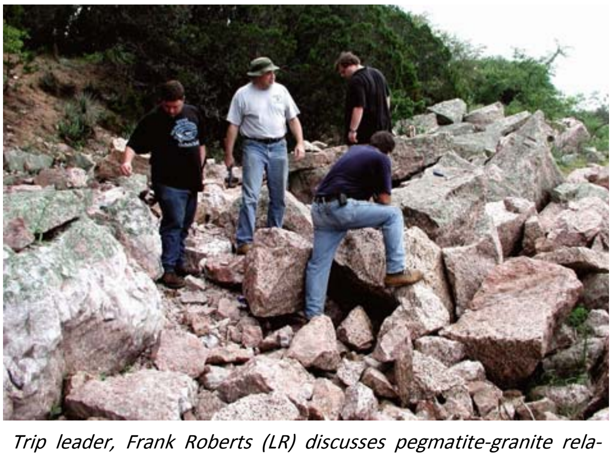
That night, we returned to the Petrick site with blacklights to search for fluorescent minerals. We saw quite a bit of fluorite (fluorescing red-purple) and managed to collect a small amount. There was also a lot of fluorescent bright green, which under regular light just looks like regular granite. Frank explained that this was actually a fine coating of secondary minerals containing uranium and other rare elements that had been deposited on the pegmatite.

Despite being a relatively short trip, we had a lot of fun, got to see lots of great examples of pegmatites in the field, and managed to bring back several nice specimen souvenirs.

Written by Stacey Evans and Paul Bowen

Matt Cleveland (right) shows Paul Bowen (left) a sample with the contact between the Cactus Jack pegmatite and its host gneiss.

Stacey Evans found the piece of pegmatite that she wanted, but no one would help her load it in the van.



Trip leader, Frank Roberts (LR) discusses pegmatite-granite relations with Matt Hamilton (L), George Morgan (M), and Matthew Cleveland (UR) in an abandoned quarry.

Depositional Megacycles in the Woodford Trough of Central Oklahoma

Christopher D. Althoff, ConocoPhillips School of Geology and Geophysics, University of Oklahoma

Abstract

The Woodford Shale is one of several Devonian/Mississippian shales that are currently being targeted for unconventional gas/oil exploration in North America. Previous studies have focused on the Woodford Shale in the Arkoma, Anadarko, and Ardmore Basins, yet there is anomalously thick, organic-rich Woodford deposited on the central Oklahoma cratonic platform. This shale was deposited in intervals exceeding 300' thick. After compaction/dewatering, subsequent uplift and episode(s) of erosion, there still remains a large area with more than 200' of Woodford Shale, with some areas exceeding 300' thick. The Woodford Shale is highly organic, gas saturated, and correlative from the west Anadarko Basin, over the Cherokee Platform and east into the Arkoma Basin.

Megacycles within this Woodford Shale package were mapped using compensated neutron/density logs and gamma ray logs from wells throughout McClain, Pottawatomie, and Cleveland counties. These cycles are highly correlative throughout the Woodford interval and provide insight into the timing of structural and stratigraphic features. The Woodford deposition was not entirely independent of the underlying topography. However, preservation of the Woodford is largely dependent on the paleogeography of the shelf, the timing of faults, and structural movement. Large areas and volumes of Woodford Shale were peneplaned off due to erosion, yet it was preserved in stratigraphic lows and downthrown fault blocks. Identifying and mapping these cycles is crucial when identifying: 1) depositional history, 2) timing of structures, 3) slump blocks and faults within the Woodford package which would not have been otherwise identifiable, 4) stratigraphic control of micro-fractures, 5) the best location for the placement of laterals, and 6) the best possible design for fracture treatment and stimulation of wells.

Regional Setting

Unconventional resource plays dominate current North American exploration. The Woodford Shale is the largest potential resource of this type in Oklahoma. Current exploration and completion in the Woodford Shale has been primarily concentrated in the Arkoma Basin of SE Oklahoma and the Ardmore Basin of south-central Oklahoma. Woodford Shale completions as of August 2008 can be seen in **Figure 1**. Outside of the basins there has been anomalously thick, organic rich Woodford preserved on the Cherokee Platform. This may serve to further extend the boundaries of current Woodford exploration and was the focus of this study.

Data Explanation

On the platform, the Woodford Shale was deposited on the post-Hunton unconformity in an anoxic marine environment. Deposition was largely independent of the underlying topography. Later uplift and exposure resulted in large areas and volumes of Woodford being peneplaned off. However, thick sections of Woodford 1-2

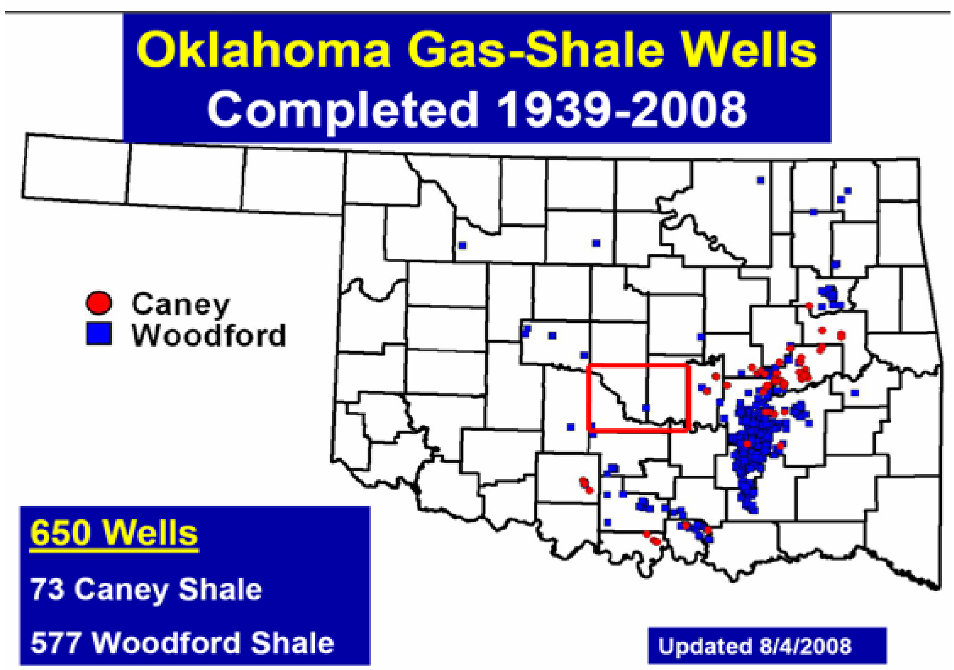


Figure1. Oklahoma state map showing Woodford/Caney Gas-Shale Wells completed 1939-2008 and the study area highlighted in the red box. Modified from Andrews (OGS), 2008.

miles wide is preserved in large erosional troughs which trend NW-SE **(Figure 2).** These erosional troughs were the result of drainage channels which flowed southeast, stripping away the resistant Hunton Group and, in places, eroding into the underlying Sylvan Shale.

Highly correlative cycles within the Woodford Shale were identified and a type log showing these cycles can be seen in **Figure 3**. These cycles were deposited over the entire area blanketing the paleogeography. The only documented occurrence of lack of deposition occurred in T7N-R2E where the lowermost cycle A is missing. This implies that this was a topographic high or that the depositional environment was not suitable for shale accumulation at this time in this location. Megacycle C thickens to the southeast showing influence of subsidence in the Arkoma Basin. The amount of Woodford which has been eroded off is reflected by the preservation of the cycles within the basins and in the deepest portions of the trough. These cycles can also be used to tell the relative timing of faults by analyzing the preservation of the cycles in surrounding wells or noting the anomalous absence or repetition of cycles. The repetition of cycles may also be the result of large slump blocks as seen in **Figure 4**. The Hunton Wash/ Meisner Sand is thickest along the trough margins and surrounding structural highs.

Isopach map of the Woodford Shale

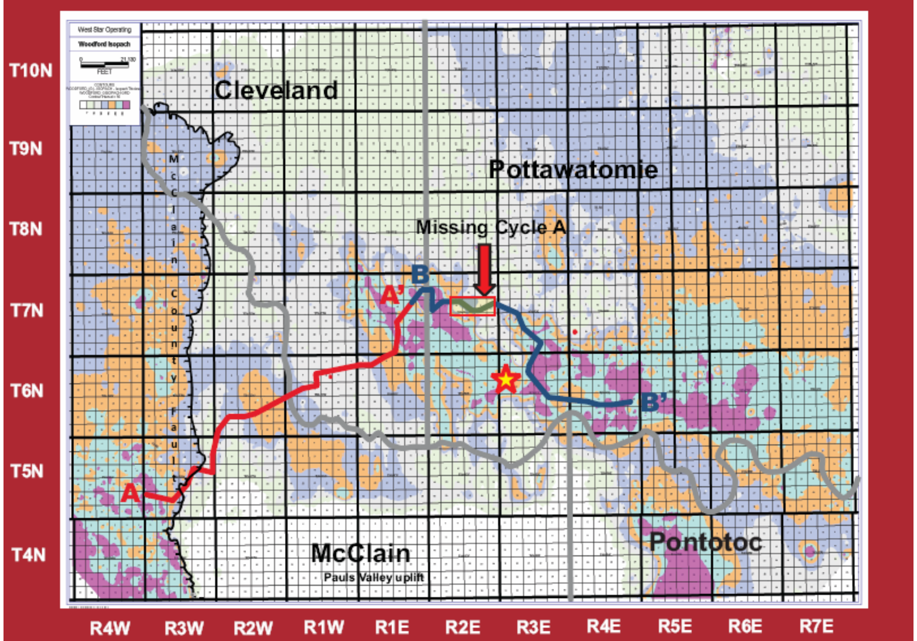


Fig. 2 – Isopach map of the Woodford shale. Note the NW – SE trending erosional trough with anomalously thick Woodford Shale preserved on the shelf. Cross-sections are marked A-A' and B-B'. The star locates the well with the slump block feature.

On isopach map the color white is 0-25 feet and purple is 200 or greater feet of Woodford.

Summary

There is significant potential for Woodford Shale exploration at shallow depths on the Cherokee Platform. To most effectively exploit this resource, detailed mapping of the depositional cycles will be critical to identify:

- Depositional/erosional history
- The relative timing of structural features
- Slump blocks and faults within the Woodford Shale
- Stratigraphic control of microfractures
- Location of "sweet spots" and the placement of laterals
- Best design for fracture treatment and stimulation

Continued Research

- Detailed analysis of 200' of core from the study area using thin sections and electron microprobe to determine the mineralogical changes within these cycles and define lithofacies within the Woodford Shale in this area
- Determine which of these lithofacies should be targeted for exploration using completion results from the field and petrophysical tests in the lab
- Determine if these facies can be imaged using calibrated 3D seismic data and applied attributes

Who cares?

- This area is a prolific oil and gas region in central Oklahoma **(Figure 5).**
- Conventional Production ~ 300 MMBO + 92 BCFG sold + unknown gas flared and vented
- All sourced from the Woodford Shale
- $V_{RoHI\ Corr}$: .91 – 1.1 (Core analysis by Dr. Charles Landis and Brian Cardott-OGS)
- G.I.P : 170 – 220 BCF/mi² (Schlumberger ECS logs)
- Gas Cut Mud: 9.3 down to 8.0 lb/gal at ~3500 ft.

Acknowledgments: Paul W. Smith, West Star Operating Company and Dr. Jim Forgotson, ConocoPhillips School of Geology and Geophysics, University of Oklahoma

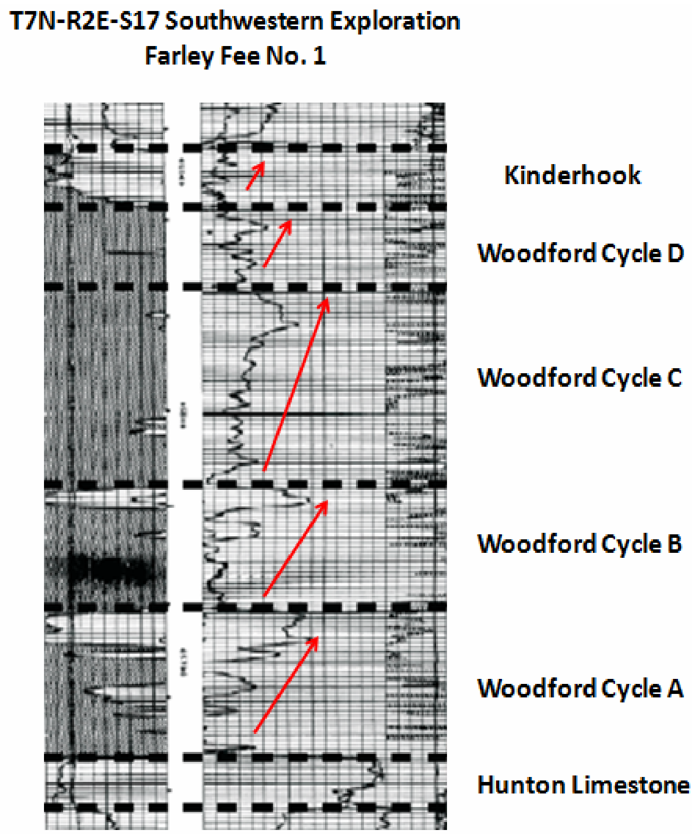


Fig. 3 *– Mappable cycles within the Woodford Shale showing coarsening upward sequences with the gamma ray cleaning up towards the top of each cycle.*

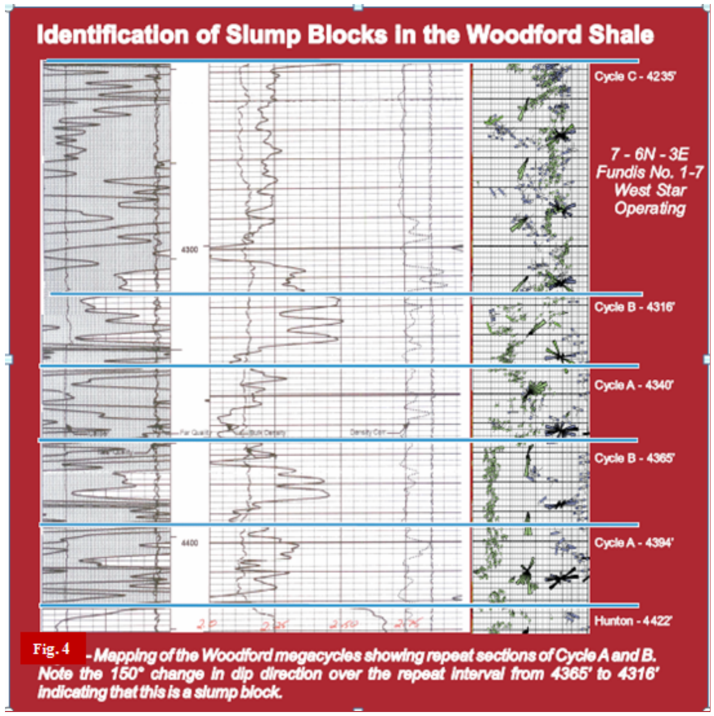


Fig. 4 *- Mapping of the Woodford megacycles showing repeat sections of Cycle A and B. Note the 150° change in dip direction over the repeat interval from 4365' to 4316' indicating that this is a slump block.*

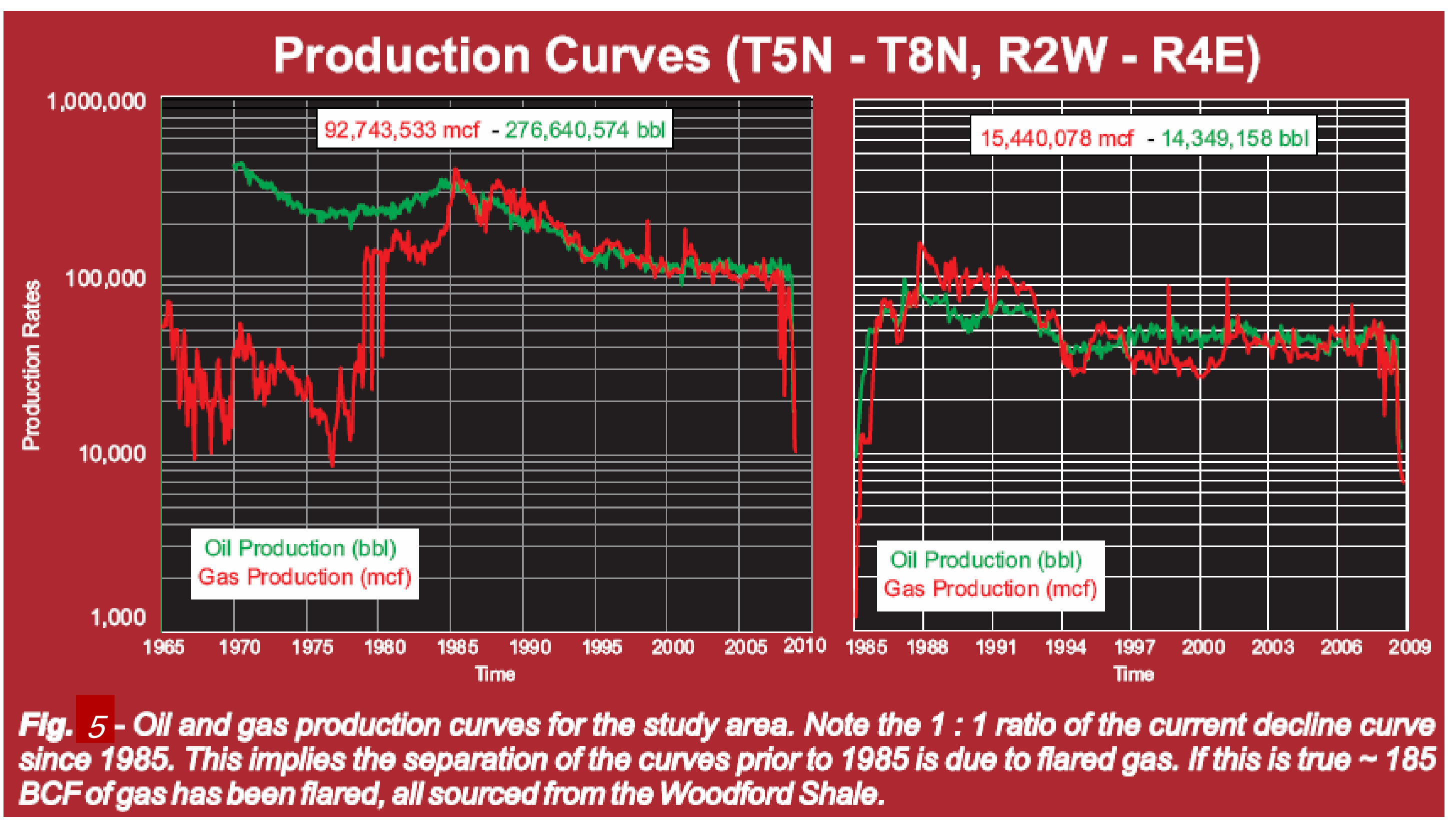
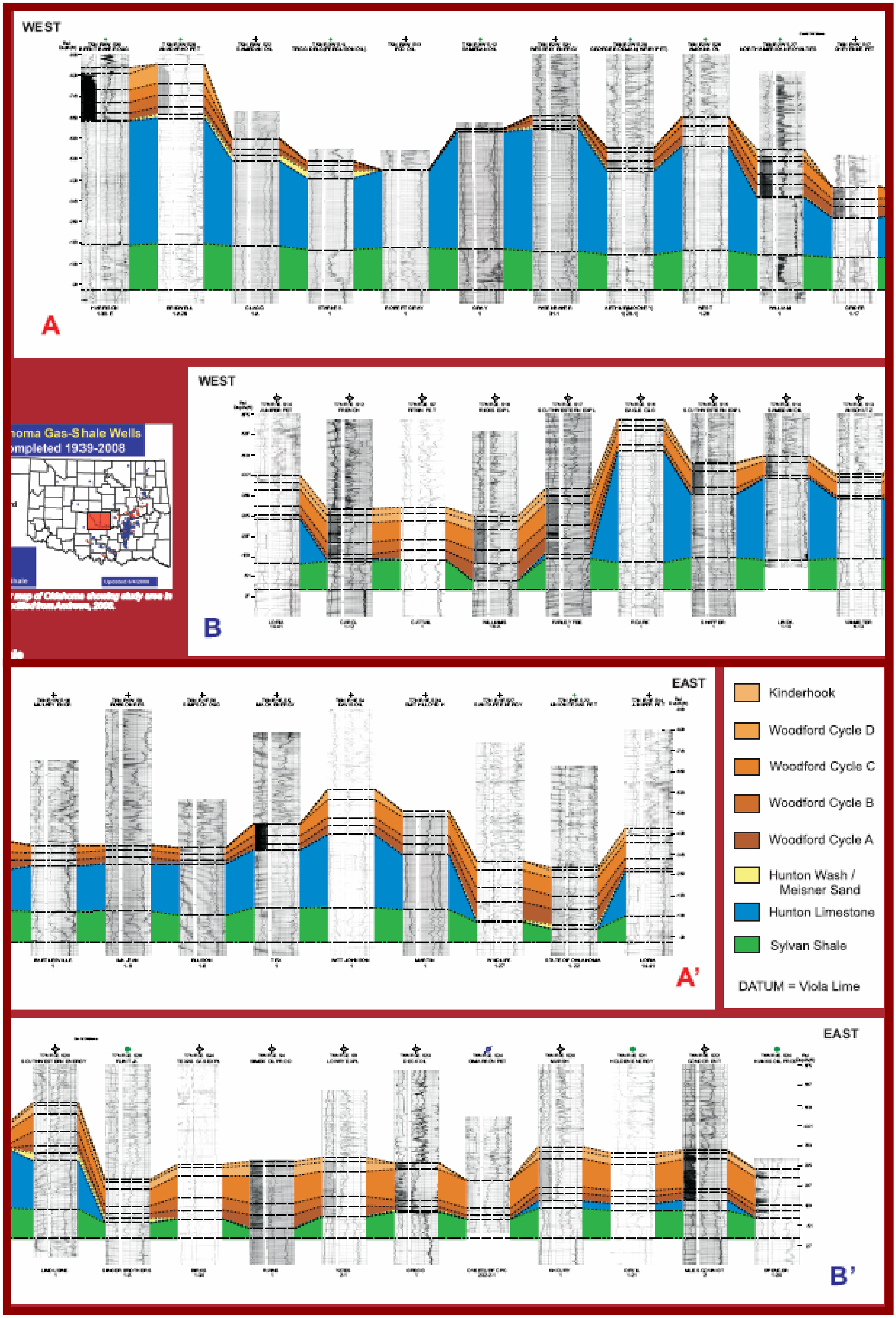


Fig. 5 - Oil and gas production curves for the study area. Note the 1 : 1 ratio of the current decline curve since 1985. This implies the separation of the curves prior to 1985 is due to flared gas. If this is true ~ 185 BCF of gas has been flared, all sourced from the Woodford Shale.

Cross Sections from the Isopach Map in Figure 2



Clustering Bed Sets from the Barnett Shale Using Diffusion Map Attributes


Bradley C. Wallet and **Roderick Perez**
ConocoPhillips School of Geology and Geophysics, University of Oklahoma

Summary
Considerable effort has been invested in developing methods for classifying and identifying facies from well logs. However, identifying facies at individual measurement points tells us little about the processes that gave rise to these individual facies. In this paper, we propose a method for clustering and analyzing bed sets from well logs. The main innovation is the use of a nonlinear method for manifold learning based upon interpoint distances. We then apply this method to gamma ray logs from the Barnett Shale and show the results. Finally, we discuss how this method may be used in workflows for hydrocarbon exploration and development.

Introduction
Shales are frequently considered to be very homogeneous lithologies deposited in calm marine environments under very slow energy conditions. However, gamma ray (GR) logs corresponding to Barnett Shale reveals a systematic vertical succession and cyclic sedimentation patterns indicating systematic changes in depositional processes and environment. At the core scale, Singh (2008) divided the Barnett Shale into nine lithofacies. Comparing these results with GR logs, it is possible to observe that high GR values correspond with phosphatic deposits while low GR correlate with calcareous laminae rich intervals, or dolomitic mudstone and reworked shelly deposits.

Singh (2008) defined fourteen gamma-ray parasequences (GRP) based upon the cyclicity and repetition of a certain number of specific lithofacies such as a vertical succession of cycles of noncalcareous mudstone and phosphatic deposits followed upward by calcareous mudstone and reworked shelly deposits. In GR logs, these GRP show three main patterns: upward – decreasing, upward – increasing, and upward – constant API values **(Figure 1).**

Picking trends is a very subjective art, and the interpretation will generally vary between different interpreters. The goal of our algorithm is to cluster and hence classify regions in a well log based upon higher order trends. We use clustering to build our model so that our data can speak for themselves concerning the underlying processes. We use a statistical approach to achieve robustness to noise and lower order variations that might otherwise disrupt non-probabilistic approaches.

Our approach is to cluster segments of well logs corresponding to bed sets. The partitioning of the well log data is done without any consideration for the composition and is done simply by the selection of sequential parts of an equal, predetermined size. We choose small sizes for the bed sets such that a relatively small percentage of these fragments will cross parasequence boundaries. The eventual goal, as discussed later in this abstract, is to mathematically model parasequences (and in turn larger processes) as piecewise sequences of clusters.

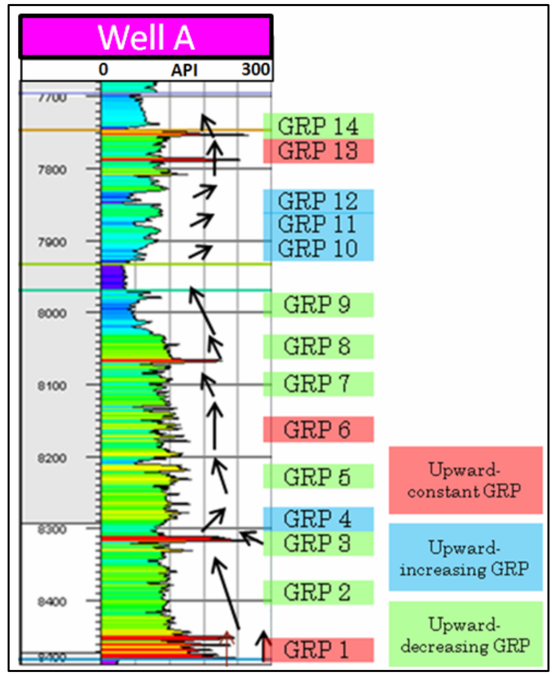


Figure 1. *Gamma ray log corresponding to well A, indicating the location and stacking pattern of each Gamma Ray Parasequence.*

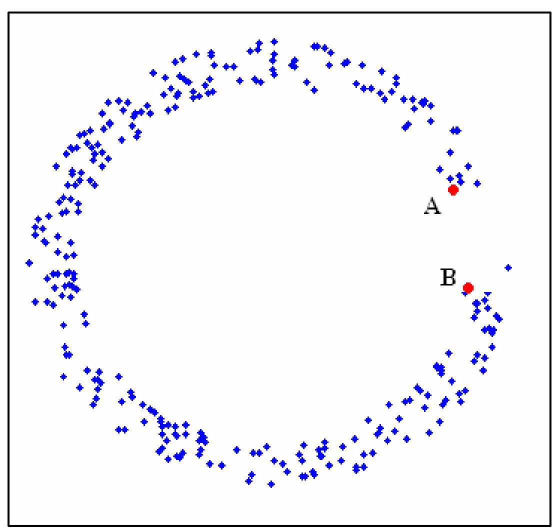


Figure 2. *This figure shows a pedagogical example of a one-dimensional data manifold embedded in two dimensions. Note that while points A and B are relatively close in Euclidean distance, they are extremely distant when measured along the manifold.*

The following sections discuss the work that we have done in respect to the problem of clustering bed sets in well log data. The next sections discuss the methodology and the technology that we have applied. We then discuss the application of our methodology to GR logs from the Barnett Shale in the Fort Worth Basin. Finally, we draw some conclusions and discuss how our approach might fit in a broader, exploration workflow.

Methodology

Our current approach involves three steps, specifically, attribute extraction, dimensionality reduction, and clustering. The approach we use ties the first and second processes together using a method called *diffusion maps* (Nadler *et al*, 2005). The application of this method is the enabling part of this effort, and it is discussed in the next section.

After using diffusion maps to define our attribute space, we use Variational Bayes Gaussian Mixture Models (VBGMM) to cluster the data (Corduneanu and Bishop, 2001). This is a modification of the statistical method of Gaussian Mixture Models that is commonly used by the clustering community, and it is used in a number of commercial packages. VBGMM differs from the standard approach in that it uses variational calculus to maximize the posterior likelihood. Additionally, it allows the destruction of superfluous clusters when their allocated mass becomes sufficiently small, allowing the data to choose the complexity of the model.

Diffusion Maps

Diffusion maps, also known as spectral clustering, is a non-linear dimensionality reduction technique based upon learning lower dimensional manifolds that present a compact representation of the data. Diffusion maps work in many situations where Principal Component Analysis fails because the data are well represented by a nonlinear manifold but not by a linear subspace.

Figure 2 shows a pedagogical example of a one-dimensional manifold in two dimensions that serves as motivation for diffusion maps. In this example, we see two points, labeled A and B, that are quite close in the two dimensional space that are, however, very distant when measured along the manifold. As suggested by this example, we should consider using a data mapping that considers the set of interpoint distances. Identically, we will choose to use a measure of interpoint.

Diffusion maps work by calculating the full matrix of interpoint similarities of a data set. Specifically, we calculate the similarities by using maximum cross correlation to each and every other point in the set. We then define the interpoint similarity for any two points, x and y, as follows:

$$S(x,y) = \exp(\text{maxcrosscorr}(x,y) - 1$$

The result of this equation is a number between 0 and 1 with 1 indicating the two signals are identical. This defines for each point an n dimensional attribute where n is the number of observations, resulting in an n-by-n similarity matrix with 1's along the diagonal. The dimensionality of this attribute space is then accomplished by calculating the principal axes of this matrix, S, with the eigenvalues of decomposition being used to estimate the dimensionality of the resulting attribute space. A detailed discussion of the mathematics of this method may be found in a number of other sources, e.g. Nadler *et al* (2006).

Diffusion maps are not defined by any concrete Euclidean space, rather they are defined by the set of interpoint distances, making them amenable to working with any data type as long as we can calculate distances between observations. Such data sets include seismic traces and fragments of well logs.

The reliance upon interpoint distances is shared with Self Organizing Maps (SOM) (Matos *et al*, 2007). SOM work by defining clusters of observations where clusters can be considered as groups of points that are of low interpoint distance. SOM simultaneously order these clusters in one or two dimensions, presumably upon some manifold. Conversely to SOM, we will first define the data manifold and then cluster the data along that manifold.

Application

To demonstrate our method, we applied it to gamma ray logs from 61 wells in the Fort Worth Basin. The logs had a 6 inch resolution, and we extracted 2311 non-overlapping five foot segments from the top to the bottom of the Upper Barnett Shale.

To define the interpoint similarities, we used maximum cross correlation, and we allowed a maximum relative shift of +/-1.5 feet. We then applied the algorithm discussed above using a maximum of six clusters.

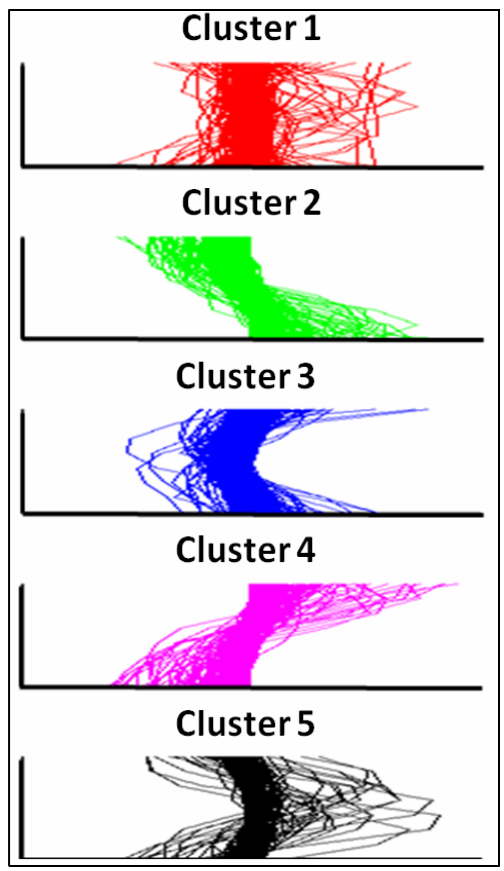


Figure 3. *Graph of the members of the five clusters as defined by our algorithm. Note that while there is variance of the members of each cluster, there appears to be a pattern defining the overall nature of the members. The segments have all been centered by having their individual averages subtracted from them.*

The VBGMM clustering algorithm dropped one cluster resulting in the five clusters shown in **Figure 3**. We note that while there is significant intra-cluster variation, the members of each cluster appear to exhibit a common character. We suggest that the intra-cluster variance is significant evidence of the robustness of the algorithm.

Figure 4 shows the mean segments associated with each of the five clusters with the same color coding as that in Figure 3. Examination of this plot reveals that all five clusters have a clearly identifiable trend: upward decreasing, upward constant, upward increasing, transitioning from upward increasing to upward decreasing and transitioning from upward decreasing to upward increasing. Such trends are reassuring since the clusters seem to have a definable label that matches our intuition about the data, and these labels appear to be complete in defining the problem.

Finally, **Figure 5** shows the GR logs for three wells with the classified segments color coded as in Figure 4. The assignment appears quite good relative to what a human interpreter might produce. There are a few discrepancies. Most of these errors, however, are associated with segments with bends in them. We will continue to refine our algorithm to resolve these.

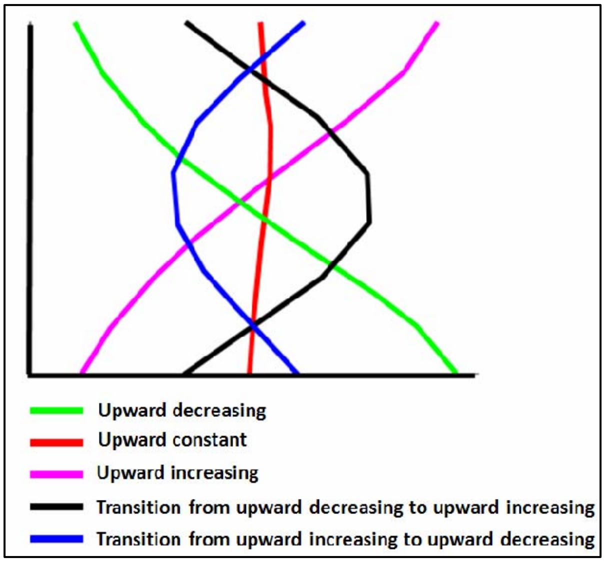


Figure 4. *This figure shows the average segments from each of the five clusters with the colors corresponding to*

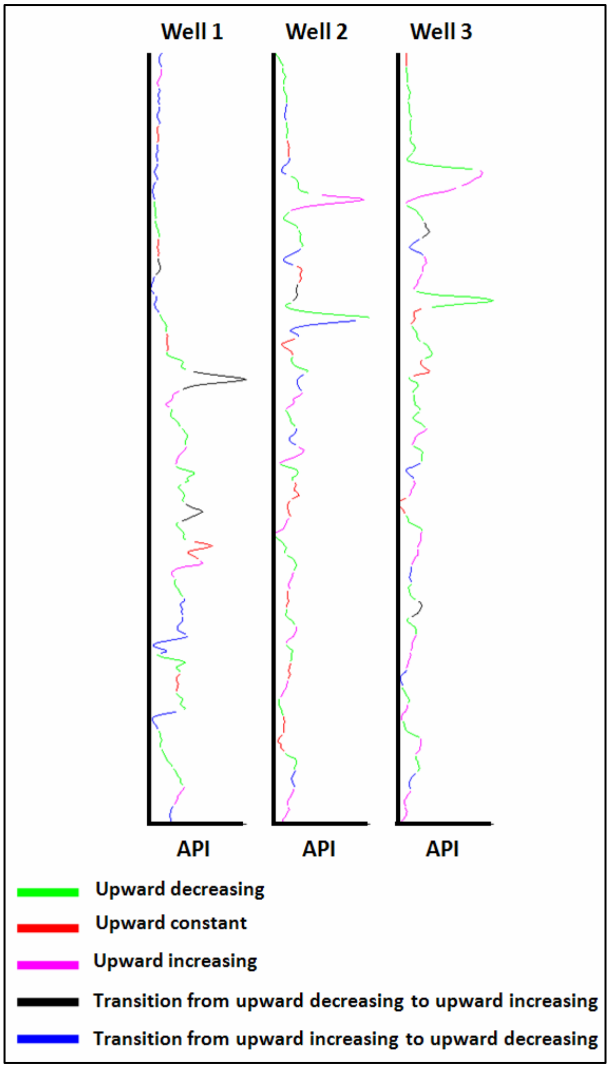


Figure 5. *This well shows the segments for three wells color coded as described in Figure 4. Note that while there are some possible errors, the encoding generally agrees with that which might be assigned by a human interpreter.*

Conclusions

In this abstract, we have presented an algorithm for clustering segments of well logs. We have applied this method to five foot sections of GR logs from the Barnett Shale. Our approach yielded five clusters corresponding to the major higher order trends one would expect in this situation. It is important to note that the results were specific to a set of input parameters, and other parameters might have yielded far more discriminatory power. While we liked the results we achieved for the purposes of demonstrating the utility of this algorithm in an easily understandable manner, more comprehensive solutions may require tuning to achieve more complex models. Also, although we are currently focusing upon GR logs, we believe the use of other logs either jointly or individually is a logical thing to do. For instance, we believe using sequences of acoustic impedance is a reasonable follow on effort which may in turn allow us to extend the clustering to seismic data.

We developed this algorithm with a broader goal of analyzing processes of larger scale than bed sets, and doing so will require further research. Our approach will focus upon probabilistic modeling. Specifically, we intend to analyze the transition probabilities associated with one bed set cluster type following another. Parasequences would then be expressed as probability sequences of our clusters allowing for insertion of events of lower order than parasequences.

Furthermore, we intend to investigate the linking of our realized clusters with seismic data and seismic attributes. Further research in this area will focus upon using cross plots and correlation analysis to discover the linkage between what can be discerned in well logs and what can be identified in seismic.

Acknowledgements

We would like to acknowledge Devon Energy for permission to use and publish the data involved in this work. Additionally, we would like to thank Tim Kwiakowski and Elizabeth Baruch for their insightful discussions that helped to frame our ideas expressed in this abstract. Finally, we would like to thank Kurt Marfurt and Roger Slatt for their encouragement.

THE EXPLORATION GAME 2009: BRISTOL BAY PROSPECT DEVELOPMENT IN A NUTSHELL

Left to right: Jonathan Funk, Diana Parada, Andrea Miceli, Oswaldo Davogustto, Advisor Dr. Roger Slatt, and Byron Solarte.

Data analysis presented to the AAPG IBA committee at the regional competition held in Tulsa, OK, April 4, 2009:

The Bristol Bay region is located along the northern portion of the Alaska Peninsula **(Figure 1)** to the southwest of Cook Inlet, one of Alaska's primary petroleum basins. The area has experienced several tectonic events that have affected the geometry of the different sedimentary basins – both compressional (accreted Mesozoic terrane) and extensional (Cenozoic backarc basin) tectonics have occurred during its geologic history. The structures in the region that affect the hydrocarbon potential are primarily related to extension. Horst-graben structures were created in the early Tertiary as the basin reopened. These structures help serve as both potential migration pathways and hydrocarbon traps.

The geochemical assessment of the region indicates Mesozoic and Tertiary strata constituting fair to good source rock potential. Mesozoic rocks are dominated by type I/II kerogen (oil-prone) and, based on vitrinite reflectance data, are shown to be mature to overmature. The Tertiary source rocks, on the other hand, are mainly composed of type III kerogen (gas-prone) and are immature to marginally mature.

One dimensional (1D) basin modeling indicates that in the Bristol Bay region, the onset of oil and gas generation occurred about 50Ma, and after an intense period of subsidence, uplift and erosion, the main phase for hydrocarbon generation occurred about 20Ma when all the petroleum system elements were in place for hydrocarbon accumulation. Presently, the oil window for gas generation (~ 0.6% Ro) lies around 13,100 ft. deep within the Tolstoi Formation, which is considered the main source rock for the region **(Figure 2).** Interpreted migration pathways are mainly horizontal through carrier beds and vertical through faults.

Well logs, 2D seismic, geochemical and core data were used to develop a sequence stratigraphic framework that was used to map and define the major source rocks, seals and the best reservoir rocks in the Bristol Bay region as well as the Ugashik Sub-basin. Highstand systems tract rocks (HST) comprising the Miocene-aged Unga and Bear Lake Formations potentially serve as the reservoir rocks in Bristol Bay and in the Ugashik Sub-basin. Transgressive systems tract strata are considered to be seals in the Bristol Bay region and the Ugashik Sub-basin onshore. The sequence stratigraphic framework was found to be a very valuable tool when correlating 2D seismic lines and the gamma-ray and spontaneous potential well logs. Reservoir quality in lowstand systems tract (LST) rocks is affected by a high volcaniclastic input that decreases the porosity and permeability with the development of the mineral zeolite which fills in some pore space. Density-porosity logs also indicate that reservoir quality decreases towards the paleoshoreline due to volcanic influence **(Figure 3).**

After evaluating the petroleum system of the region, five (5) major plays were identified: Bristol Bay Basin, Amak Basin, Black Hills Uplift, Ugashik Sub-basin and St. George Basin. Within the five plays, four prospects were defined: Tristar, Wishbone, BA, and Piano **(Figures 4, 5 and 6).** Various factors such as sequence stratigraphy, structural elements, reservoir quality, possible seals and direct hydrocarbon indicators were considered for this assessment.

Many different things were considered when developing the prospects. These include, but are not limited to, quantity and quality of data, probabilities of source, reservoir, and seal rocks, potential migration pathways, the trapping mechanisms and overall timing of the petroleum system. Through the risk evaluation, the highest probability of geological success was assigned to the Tristar prospect (Pg=59%) in the Bristol Bay Basin. The biggest determined risk was the migration pathway. The Wishbone prospect was assigned a very low probability of geological success (Pg=10%) due to limited data associated with the Amak Basin. There were some encouraging factors but the fact that the Amak Basin is untested really increased the risk associated with the prospect.

Volumetric estimation was completed using probabilistic methods (Monte Carlo Simulation) for the four defined prospects. This resulted in a total of 94.4 Bcf of mean recoverable gas. The overall probability of success showed that the Piano, Tristar and BA prospects are economically viable at 3 dollars per Mcf **(Figure 7).**

Both technical and economic recommendations are made for further development of the area. These include: drilling any of the three most economical prospects, drilling a Continental Offshore Stratigraphic Test (COST) well in the Amak Basin, acquiring 3-D data for all the prospective areas, and evaluating the potential of the Mesozoic oil-prone source rocks **(Figure 8).**

Figure 1: Bristol Bay area location

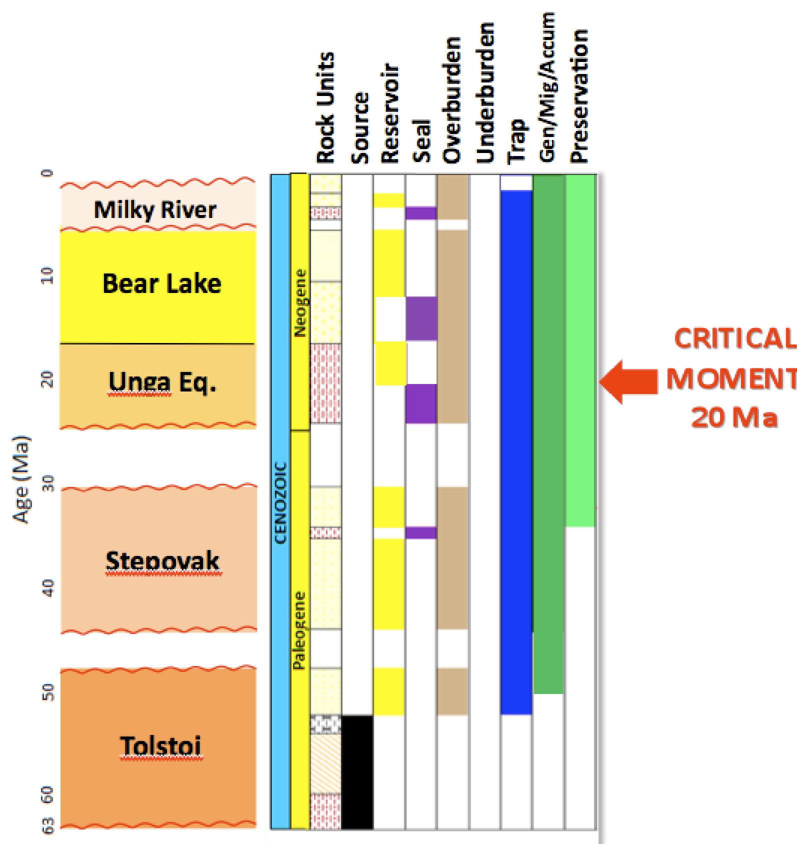


Figure 2: Petroleum systems chart for the Bristol Bay Area

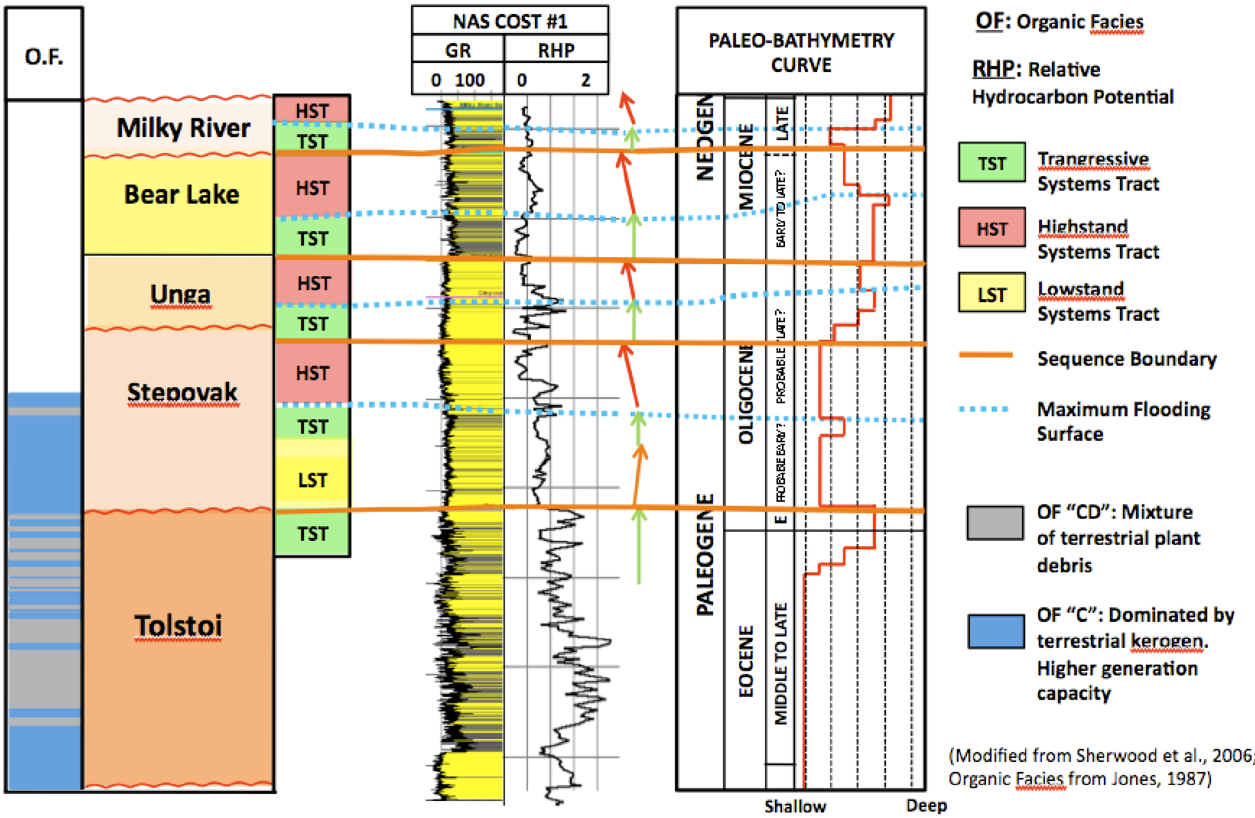


Figure 3: Sequence stratigraphic framework for the Bristol Bay Area

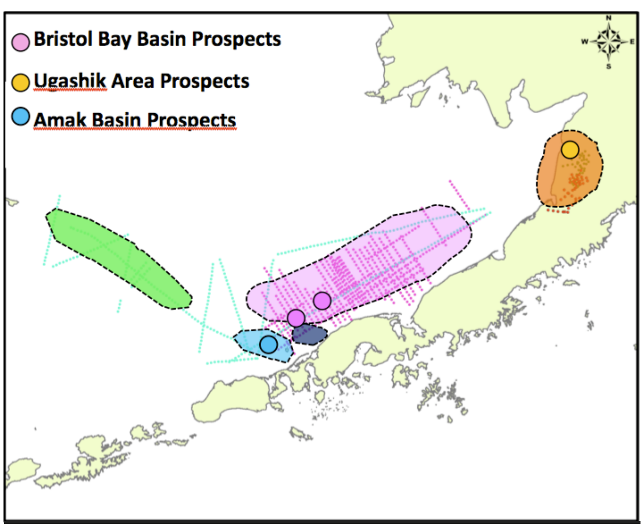


Figure 4: Bristol Bay play areas and prospects

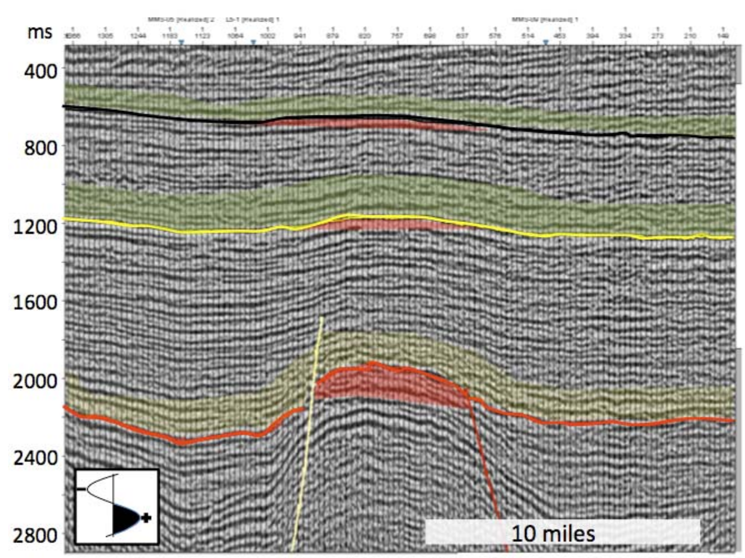


Figure 5: Tristar prospect seismic section

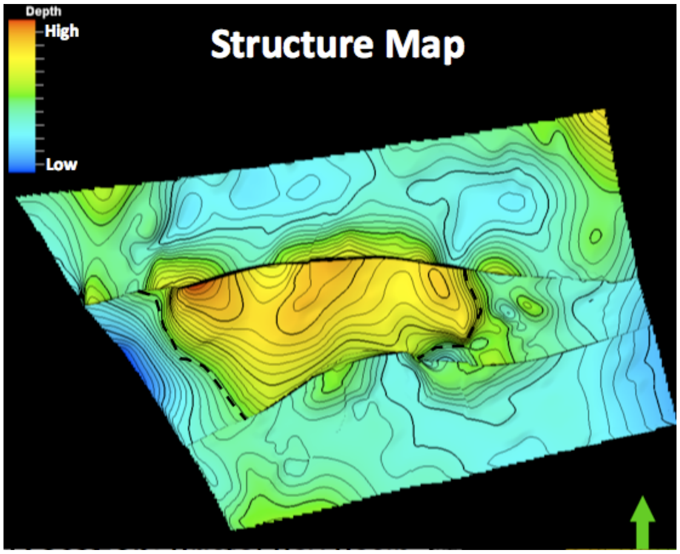


Figure 6: Structure map of the Tristar 1 prospect

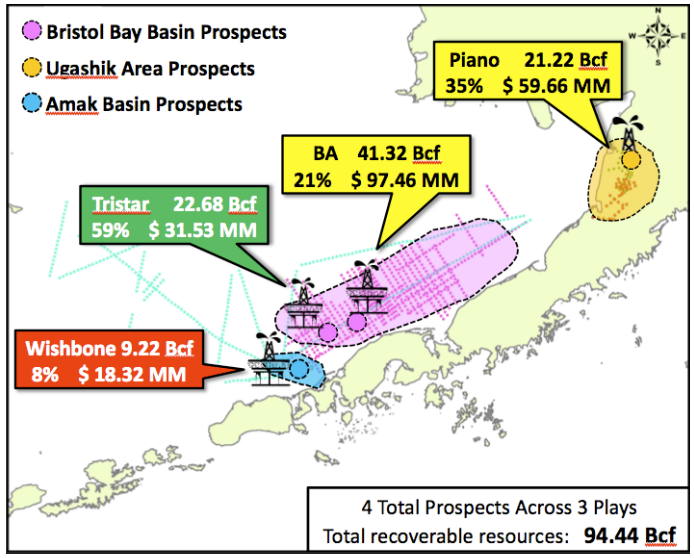


Figure 7: Bristol Bay area prospects with recoverable resources and mean PE

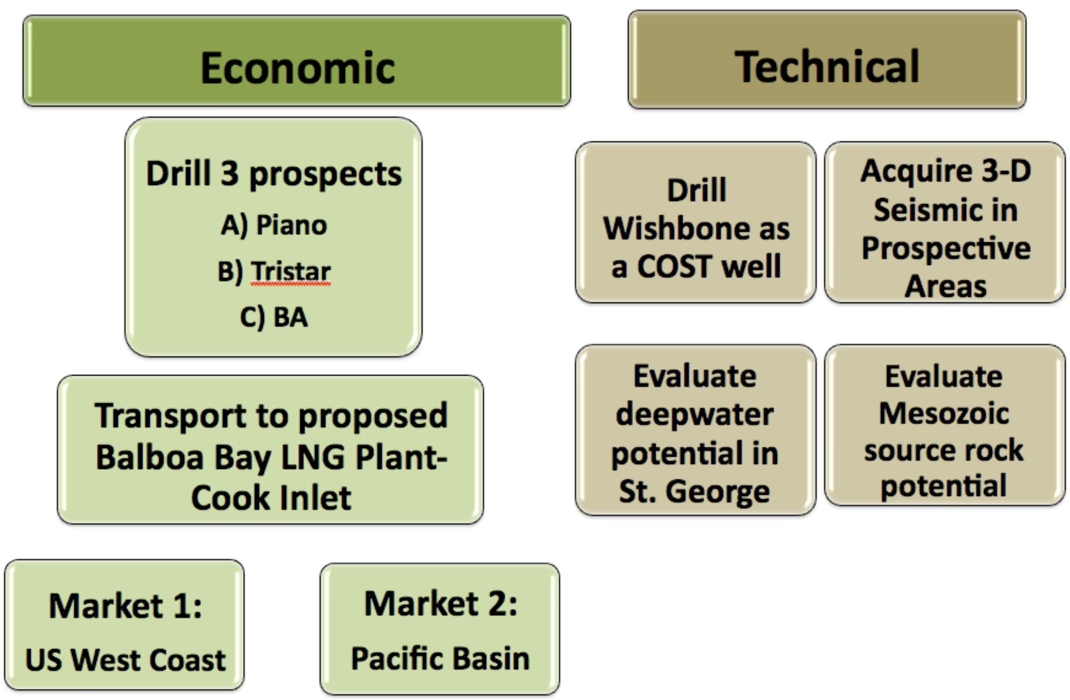


Figure 8: Technical and economic recommendations for the Bristol Bay area development

Karst Features of the Arbuckle and Simpson Limestones in South-Central Oklahoma

Kevin Blackwood, *ConocoPhillips School of Geology and Geophysics, University of Oklahoma*

B.S. in Geology

The Arbuckle and Simpson Groups crop out in an area of approximately 350 square miles in south-central Oklahoma. Riddled throughout these limestones are hundreds of caves, some exceeding a mile in length and containing many large and elaborate speleothems. In January 2009, I joined with others to initiate a survey of these caves.

The scope of our work involves locating and mapping the caves, as well as taking notes on the cave geology and of the various biota that inhabits the caves. More recently, many of the landowners living atop the Arbuckle-Simpson aquifer have requested hydrologic information on the caves that reach the water table to assist in drilling water wells for livestock. In total we have been granted access to more than 100,000 acres of land atop the outcrops and have documented and surveyed more than 140 caves with hundreds more discovered but have yet to collect data from within them.

The science we use in locating the caves involves finding a fault or major fracture and following it until an opening is found which is big enough for a human adult to enter. Our success rate is relatively high and we have found new caves on every trip out, most of them being vertical pits with very narrow passages following the strike of the fault.

Another method we have used in locating caves involves simply following stream valleys up gradient until we encounter a spring. Some of the largest caves in the Arbuckle and Simpson Groups occur as spring caves and were likely formed at or slightly below the elevations of a paleo water table. The spring caves also contain the most elaborate of the speleothems and have the most abundant and varied biota.

Entering a spring cave formed along a bedding plane in the Joins Formation.

Inside a karst resurgence spring.

There are many limestones within and surrounding the Arbuckle and Simpson uplift areas; however, only a few of the formations seem to harbor an abundance of caves. Though some caves occur in the Viola Limestone, the majority are found in the Cool Creek, McKenzie Hill, West Spring Creek, and Kindblade Formations, with several small caves formed in the Joins. Knowing which formations the caves occur in most frequently has increased our chances of finding them.

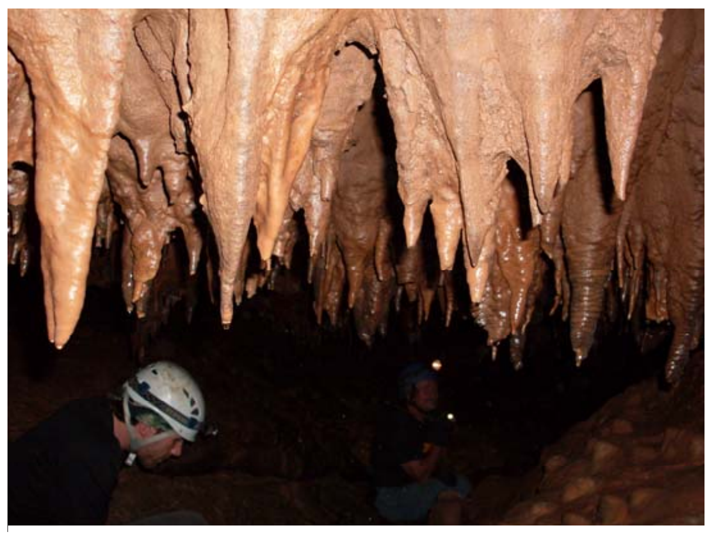
Finding caves that permit access to the water table has appeared to be our greatest challenge. Future plans include measuring depth to the water table in existing wells and using the data to build more detailed potentiometric maps to better infer where and what depth approximately the water lies beneath the surface.

ACKNOWLEDGMENTS

I want to thank Bob Allen, Neil Suneson, and Marco Micozzi for inspiration and resources; Dennis Thompson, Bob and Mason Horanzy, Zay Shaeffer, Stacy Blackwood, Mary Hicks, Chris Dearner, Taber Halford, Steve Herman, Andy Harris, Brian Harms, and G.O. Graening for not letting me cave solo; the landowners for granting us access; and the University of Oklahoma for its resources.

Fissure cave

Inspecting a sinkhole



Stalactites dripping with water in a formation room

Rattlesnake skeleton near the entrance of a cave

Did you know?

Speleology is the scientific study of ***caves*** and other ***karst*** features, their make-up, structure, physical properties, life forms, history, and the processes by which they form *(speleogenesis)* and change over time *(speleomorphology).*

Speleology is a cross-disciplinary field that combines the knowledge of chemistry, biology, **geology,** physics, meteorology and cartography to develop portraits of caves as complex, evolving systems.

Yearbook 2009

Doug Elmore and Levi Pack on Dr. Elmore's sailboat "Sunfish" at the 2008 "Back-to-School" Mixer, Thunderbird Lake.

State of the School

As presented to the Alumni Advisory Council, April 17, 2009 by Doug Elmore, Director

http://geology.ou.edu

TEACHING

Faculty taught an average of 4 courses/year in 2008.

We are offering "Subsurface Methods" again this semester, taught by OGS staff (Neil Suneson, Dan Boyd and Rick Andrews). Nine students have enrolled.

We also taught many general education courses for non-majors.

- Stratigraphy and Structural Geology
- Introduction to Petroleum Geology and Geophysics
- Petroleum Geology for Business Majors

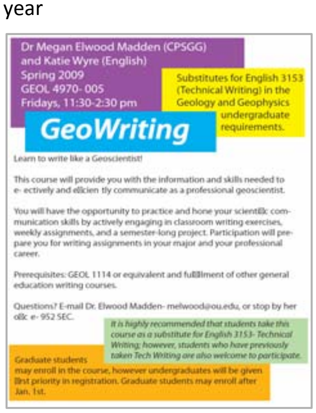
We are also continuing to work to develop more cooperation with the Survey. There is a joint appointment with Randy Keller.

Current Faculty Status:

- 11 Full-Time Tenured Faculty
- 2 Full-Time Tenure Track Assistant Professors—Katie Keranen will join us in Fall09 to make it 3.
- 4 Tenured Faculty with Split Apppointments
- 1 Ranked Renewable Term
- 1 Split Research Appt.

Vacancies

Maybe Petroleum Geology next year



Dr Megan Elwood Madden (CPSGG) and Katie Wyre (English)
Spring 2009
GEOL 4970- 005
Fridays, 11:30-2:30 pm

Substitutes for English 3153 (Technical Writing) in the Geology and Geophysics undergraduate requirements.

GeoWriting

Learn to write like a Geoscientist!

This course will provide you with the information and skills needed to e- ectively and efficien tly communicate as a professional geoscientist.

You will have the opportunity to practice and hone your scientific communication skills by actively engaging in classroom writing exercises, weekly assignments, and a semester-long project. Participation will prepare you for writing assignments in your major and your professional career.

Prerequisites: GEOL 1114 or equivalent and fulfillment of other general education writing courses.

Questions? E-mail Dr. Elwood Madden- melwood@ou.edu, or stop by her office- 952 SEC.

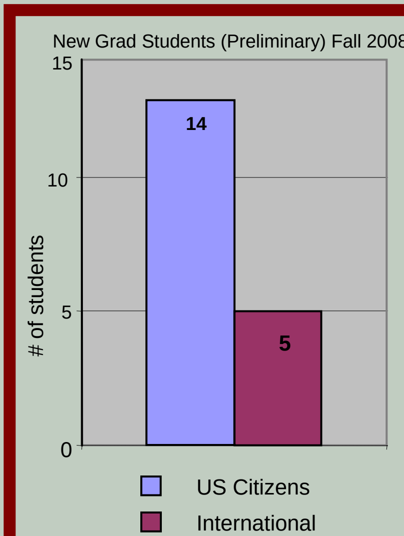
It is highly recommended that students take this course as a substitute for English 3153- Technical Writing; however, students who have previously taken Tech Writing are also welcome to participate.

Graduate students may enroll in the course, however undergraduates will be given first priority in registration. Graduate students may enroll after Jan. 1st.

STUDENTS

New Grad Students (Preliminary) - Fall 2008

- Very successful recruiting this year due to:
  - ⇒ Recruiting booths at AAPG, SEG, and GSA
  - ⇒ Faculty contact grad prospects
  - ⇒ Visits to campus
  - ⇒ Online application
  - ⇒ Enhanced offers
  - ⇒ New funds from the Grad College
- 200% increase in applications (>130 by 02/01/09)
- Very significant quality increase
- 7 enhanced offers have been accepted



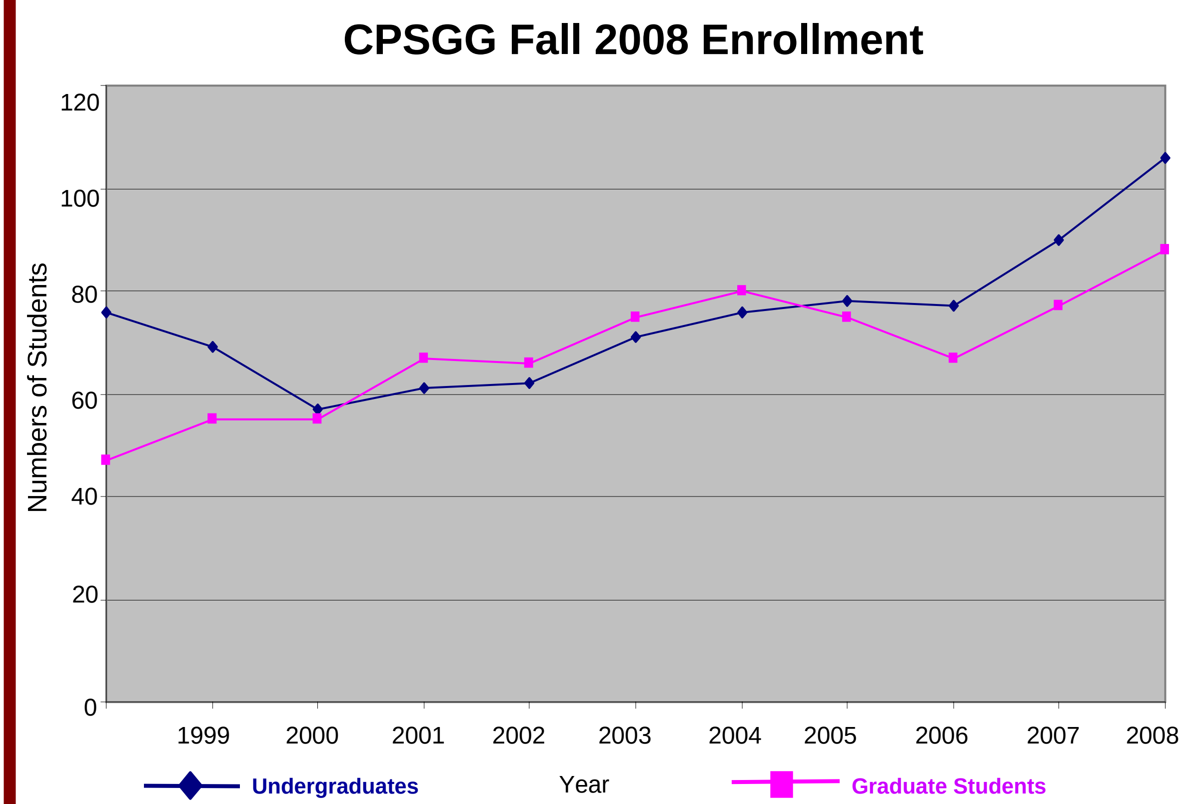
Field Camp 2009

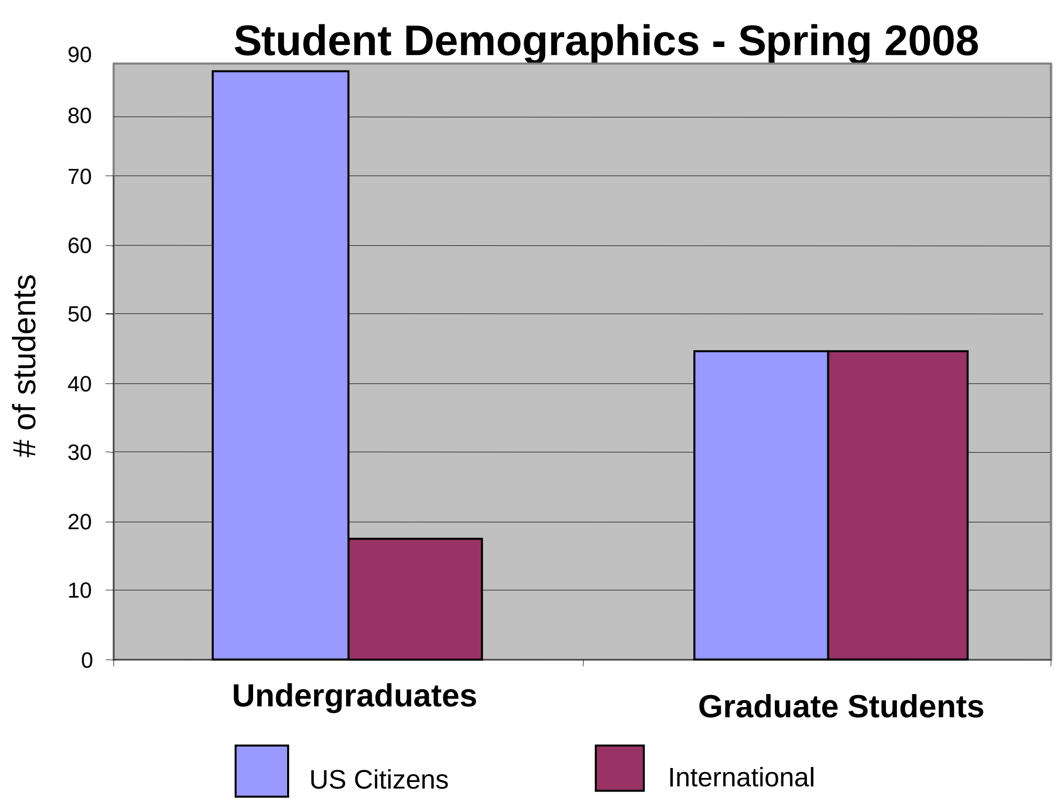
- Back to the OSU camp—19 OU students, 60 total students, 4 faculty
- More later on Field Camp 2010

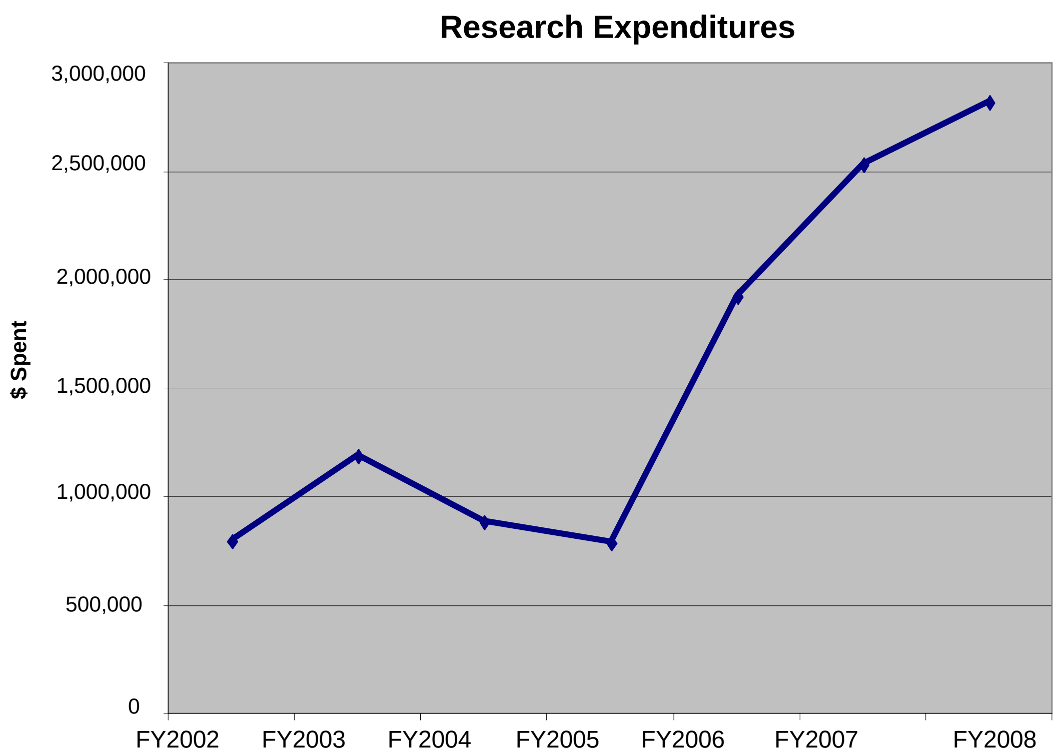
Field Trips

- Freshman trip—Spring 2008
- Freshman trip—Spring 2009, 21 students signed up

New **Geowriting course this semester taught by Megan Elwood Madden and the English Department TA


CPSGG Fall 2008 Enrollment
Numbers of Students
120
100
80
60
40
20
0
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Undergraduates
Year
Graduate Students


Student Demographics - Spring 2008
# of students
90
80
70
60
50
40
30
20
10
0
Undergraduates
Graduate Students
US Citizens
International



RESEARCH PROJECTS

- Attribute-Assisted Seismic Processing and Interpretation (Consortium—Marfurt)
- Improving Geologic and Engineering Models of Midcontinent Fracture and Karst Modified Reservoirs using 3-D Seismic Attributes (DOE—Marfurt)
- Diagenesis of the Barnett Shale and Ellenburger Group (Fort Worth Basin): Timing and origin of karsting- fracturing-faulting as well as associated fluid migration and other events (Devon—Elmore)
- Integrated Sequence/Seismic- and chemo-, -stratigraphic studies at OU (Devon—Slatt and Philp)
- Natural Earthquake Laboratory in South African Mines (NELSAM—Reches)
- GEON (the Geosciences Network)-NSF-funded collaborative project on need for 3-D and 4-D models of lithospheric structure (Keller)
- Dust as an archival agent in Late Paleozoic Pangea (NSF—L. Soreghan and M. Soreghan)
- Diversity in the Geosciences: Development of a Pipeline for Native American Students at OU (NSF) (Joint project-CEE, A&S, (Elmore PI)
- Water and carbon reservoirs: Gas hydrates on Mars (NASA) (Megan Elwood Madden)
- Jarosite lifetimes on Mars (NASA) (Megan Elwood Madden and Andy Madden)
- Poromechanics and other Consortiums/Contracts (Abousleiman)
- Pacific Northwest Case Study (NSF) (Keller)
- Development of an experimental system for analyzing the rheology of dense granular materials and fault gouge under seismic conditions (NSF) (Reches)
- Collaborative Research: Foreland basin development and biotic change in Late Ordovician trilobite faunas of eastern North America (NSF) (Westrop)

Twelve faculty have grants that contribute significantly to research expenditures.

CPSGG 2008 CAMPAIGN STATUS

"THANK YOU, BP!"
Sedimentology Field Trip

Summer Field Camp

2008 Back-to-School Mixer

Total Donations = $ 22,070,932 (from MCEE)

Other Donations:

Becker	$15,000
Shell	$28,500
Devon	$20,000 (for undergrad fellowships)
Chevron	$30,000
BP	$ 2,500 (for field trips)
ExxonMobil	$ 4,500
Marathon	$ 1,000
Questar	$20,000
Drake-Gungoll	$30,000 (for field camp)

Scholarships

- Increased numbers
- Increased amount by 15% (tuition increased 9.9%)
- Typical amounts per semester:
  - ⇒ $1800-2000 Freshman/Sophomores
  - ⇒ $3000-4000 Juniors/Seniors
- Also working with students who need help because of recent financial meltdown.

~ $17,000 in scholarships to 19 students going to field camp this summer

Graduate Support (TA and RA)

- ⇒ $900,000
- ⇒ ~400k TA

There's some concern about yearly support from companies.

CPSGG AWARDS AND RECOGNITION 2009

celebrate

Spring Picnic Award Ceremony

At the End-of-the-Year Spring Picnic, May 9th, Lion's Park, the following students and faculty received recognition:


David Stearns Award for Outstanding Geology Student
ANDREW THIEL


Alan Witten Award for Outstanding Geophysics Student
ALIYA URAZIMANOVA


Stan Cunningham Award for Excellence in Teaching
CARLOS RUSSIAN


Ben Hare Award for Excellence in Geology and Geophysics
BRIAN HARMS


Rock Award for Outstanding Volunteerism and Stewardship
CARLOS SANTACRUZ
ELIZABETH BARUCH


Outstanding Member Award, AAPG Student Chapter
RODERICK PEREZ


Special recognition for organizing the marathon
CATHERINE COX


Special recognition for being uncoordinated
VINCENT HEESAKKERS

The following award recipients were not available for a photo:

Dustin Sweet, Ben Hare Award, Excellence in Geology and Geophysics
Matt Cleveland, Stan Cunningham Award, Excellence in Teaching
Beth Hogrefe Postelwait, Charles N. Gould Award for O/S Senior
Mohammed Salih K. Altarooti, Estwing Hammer Award for O/S Senior

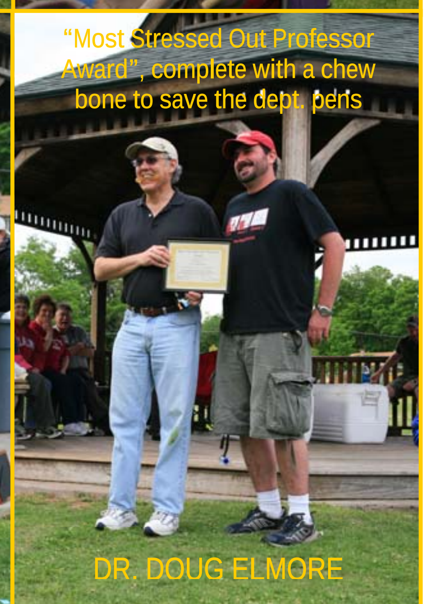

Gloria becomes an "Okie".
GLORIA ROMERO


Special recognition for outstanding "naked" research
MATTHEW MILLER


Bottle of Bubbles awarded to Dr. Marfurt for his bubbly personality
DR. KURT MARFURT


Donna Mullins "Go Fly A Kite" Award
JONATHAN FUNK


Special recognition for the "Edamame Debauchery"
JONATHAN FUNK


"Most Stressed Out Professor Award", complete with a chew bone to save the dept. pens
DR. DOUG ELMORE

celebrate

celebrate

2009 Annual Softball Showdown

l to r standing: Elizabeth Baruch, Rafael Sierra, George Morgan, Carlos Santacruz, Olubunmi Elebiju, Supratik Sarkar, Victor Pena, Dr. Randy Keller; l to r kneeling: Steven Madrid, Brad Wallet, Matt Kendall, Yoryenis del Moro, Roderick Perez (Captain), Thad Eccles, and Grant Heard.

l to r standing: Kui Zhang, Jonathan Funk, Jo Pannalal, Andrew Thiel, Devin Dennie (holding Logan Thomas), Matt Zechmeister, Oswaldo Davogustto (Captain), El Chino, Fuge Zou, Carlos Russian; l to r kneeling: Byron Solarte, Rachel Barber, Gloria Romero.

AAPG Imperial Barrel Award

2009 IBA Team, left to right: Jonathan Funk, Andrea Miceli, Oswaldo Davogustto, Diana Parada, Byron Solarte. The team placed second in the Regional competition held in Tulsa on April 4, 2009. According to those present, the team was flawless and we are very, very proud of them!

NATALIA LEON-DIAZ
Outstanding Student Award
Tulsa Geological Society

BRADLEY WALLET
Award of Merit for Student Paper
SEG

ADRIANNE FOX
Hourly Employees Distinguished Performance, OU / CPSGG

2009 SEG Sooner Challenge Bowl

1st Place Winners: (L to R) Oswaldo Davogustto and Brad Wallet, pictured here with Peter Duncan from SEG. Oswaldo and Brad will compete in the challenge bowl at the SEG International Exposition held in October in Houston. The Bowl is part of the Spring Expo.

2nd Place Runners Up: (L to R) Jonathan Funk and Jeffrey Chang, pictured with Peter Duncan from SEG. Jon and Jeff will compete in Houston in the event Oswaldo and Brad cannot appear.

Oklahoma City Geological Foundation, Spring Awards

The Foundation's Jason Hamilton is shown presenting **Alisan Templet** with her ceremonial check for $5,000 as the recipient of the Frederick H. and Lois M. Kate Endowment Award. *(Photo courtesy of the OCGF)*

Foundation Director, Lance Ruffel, presents Nabanita Gupta with her ceremonial check for $5,000 as the recipient of the Suzanne Takken Award. *(Photo courtesy of the OCGF)*

Spring Break Student Expo Poster Winners

1st Place Geophysics Winner: Judge Dave Campbell congratulates Victor Pena for winning first place in the geophysics category of the Expo poster contest.

1st Place Geology Winner: Judge Dave Campbell congratulates Christopher Althoff for winning first place in the geology category of the Expo poster contest.

celebrate

Oklahoma City Memorial Marathon

On April 26, 2009, three marathon relay teams from the Mewbourne College of Earth and Energy ran in the Oklahoma City Memorial Marathon. Each team made up of undergraduate students, graduate students, and faculty divided up the grueling task of running the 26.2 miles. Each team successfully accomplished this task after many months of training. Team OU Earth& Energy #2 received 5th place overall in the College Relay team division. Generous donations from the ConocoPhillips School of Geology and Geophysics, SEG OU Student Chapter, and Dean Larry Grillot of the College of Earth and Energy made this event possible.

Standing left to right: *Justin Newman, Catherine Cox, Alisan Templet, Roderick Perez, Jason Moncrieff;* knelling left to right: *Dustin Sweet, Mike Soreghan, and Rachel Barber.*

Runners and Teams

OU Earth & Energy #1
Jason Moncrieff
Brian Park
Roderick Perez
Ze'ev Reches
Jeremy Fisk

OU Earth & Energy #2
Mike Soreghan
Catherine Cox
Michael Merrell
Dustin Sweet
Alisan Templet

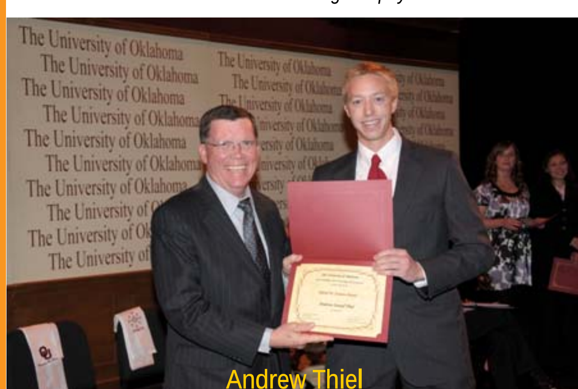
Quartz Cowboys
Ben Davis
Rachel Barber
Allison Stumpf
Amy Newman
Justin Newman

2009 Campus Awards Ceremony

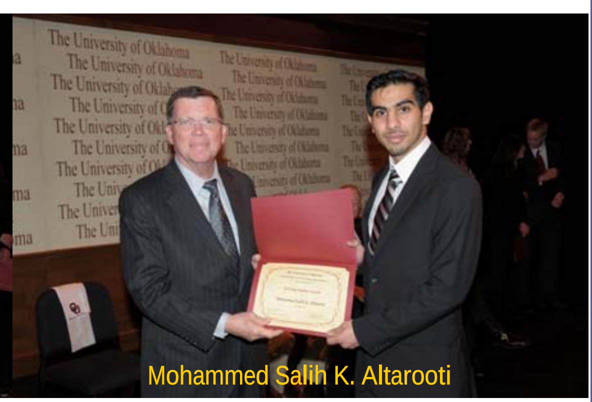
These students were also honored at our 2009 Spring Picnic for these awards.

Alan Witten Award for Outstanding Geophysics Student

Charles N. Gould Award for Outstanding Senior



David Stearns Award for Outstanding Geology Student



Estwing Hammer Award for Outstanding Senior

2008-2009

SCHOOL EVENTS

2008 Back-to-School Mixer

Thunderbird Lake, Clear Bay Café, September 12th

2008 Fall Recruiting

Onsite at Sarkeys Energy Center, September—November

We would like to thank these sponsors for supporting the 2009 Spring Break Student Expo

Shell
Chesapeake
Devon Energy
SEG
Chuck Noll, Jr.
CGG Veritas
MMS
EnCana Oil & Gas
Noble Energy
Fugro Seismic Imaging
Chevron
Continental Resources
Schlumberger
I H S
Kirkpatrick Oil
Core Laboratories
Questar
MAP Exploration
SandRidge Energy
Marathon Oil
ExxonMobil
Mewbourne Oil
Jon Withrow
BP America
Mt. Dora Energy LLC
Nexen Petroleum
Brian E. O'Brien
Robert L. Stephenson
Myra B. Ward
ConocoPhilliips
Robert W. Allen
Dave Campbell
Jim Caylor
Bill Clopine
Kate Moore
Marlan Downey
Burk Royalty Company LTD
Oklahoma Geological Survey

The following companies participated in our 2008 Fall Recruiting Event:

Mewbourne Oil
SandRidge Energy
Anadarko
Shell
Noble Energy
EnCana Oil & Gas
Chevron
ConocoPhillips
Hess
Devon Energy
Citation
EOG Resources
Questar
Marathon Oil
Apache
Chesapeake
Newfield
ExxonMobil
HighMount
Schlumberger
Ward Petroleum
Oxy
Cimarex
Kirkpatrick Oil

2008 Holiday Mixer / White Elephant Gift Exchange

OMU, Beaird's Lounge, December 12th

COSTUME CONTEST

1st—Andrew Thiel
2nd– Catherine Cox
3rd—Rod Perez/Carlos Russian tie

PUMPKIN CONTEST

1st—Jonathan Funk
2nd– Jordin Tipton
3rd—Roderick Perez

CHILI CONTEST

1st—Shamik Bose
2nd– Jennifer Hargrave
3rd—Johari Pannalal

2008 OktoberFest—Costume/Pumpkin Carving Contests/Chili Cook-Off

Sarkeys Energy Center, October 29th

1st Annual Kick-off Golf Tournament

University of Oklahoma, Jimmie Austin Golf Club, March 11, 2009

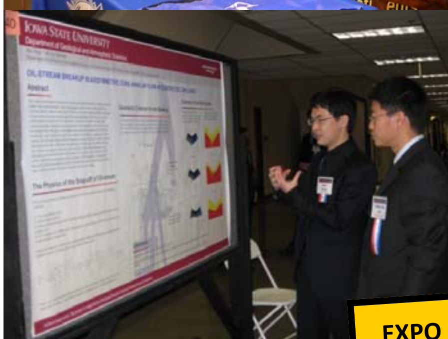
THE WINNING TEAM

This year's first ever AAPG/SEG Spring Expo Kickoff Golf Tournament was a great success. It was held on Wednesday, March 11th at Jimmy Austin University Golf Course. Although the weather was a windy 35 degrees for much of the day, players were in high spirits. Fifty-six players registered to play in the event, which included a near 50/50 mix of students from both Oklahoma and visiting schools, as well as members of the oil and gas industry who chose to support AAPG and SEG. Before the tournament began, a 100 ft. putting contest was held, and a brand new Ping putter went to the winner, Ben Davis. Prizes were awarded to the top three teams, as well as closest to the pin and long drive contest holes. The winning team consisted of Scott Heape, Monta Sewell, Carlos Santacruz, and Austin Heape with a score of 62.5 after handicaps were factored in. In the end, AAPG and SEG were able to raise over $1000 which will greatly help each organization. We hope to make this tournament a tradition in the following years; so we hope that all of those who played will return to play again next year. We would also like to extend one last thank you to all the sponsors who made the tournament possible. The volunteers for this golf tournament included all the cabinet members of the AAPG and SEG student organizations, but was spearheaded by myself (AAPG vice-president) and Jon Funk, a first-year graduate student.

Article written by **Austin Scott Heape,** *University of Oklahoma, MS Student in Geology; Photos provided by Roderick Perez.*

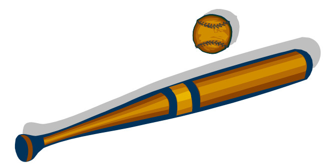
2009 Spring Break Student Expo

University of Oklahoma, Sarkeys Energy Center, March 12—14



EXPO STATS

- 222 student registrations; 205 attended
- 37 sponsors
- 22 company booths
- 12 companies conducted interviews
- 41 poster entries
- 62 different universities represented



2009 End-of-Year Picnic and Awards Ceremony

Lions Park, May 9th

The students formed two softball teams and competed in the 2nd Annual Softball Showdown. The G&G All-Stars, captained by Roderick Perez, pulled off a narrow victory over the Demolition Machine, captained by Oswaldo Davogustto.

The winning team has their team name engraved on a trophy and displayed in the 8th Floor showcase.

See photos of the two teams in the Awards Section!

DOCTORATES AND MASTER DEGREES AWARDED

Kajari Ghosh, *Doctor of Philosophy in Geology*
Jennifer E. Hargrave, *Doctor of Philosophy in Geology*
Paul McColgan, *Doctor of Philosophy in Geology*
Efrain Mendez-Hernandez, *Doctor of Philosophy in Geology*
Gloria Amparo Romero Otero, *Doctor of Philosophy in Geology*
Prerna Singh, *Doctor of Philosophy in Geology*
Sohini Sur, *Doctor of Philosophy in Geology*
Dustin Edman Sweet, *Doctor of Philosophy in Geology*
Benjamin Drenth, *Doctor of Philosophy in Geophysics*
Olubunmi Olumide Elebiju, *Doctor of Philosophy in Geophysics*
Ha Thanh Mai, *Doctor of Philosophy in Geophysics*
Maxwell S. Okure, *Doctor of Philosophy in Geophysics*
Ali Faiyaz, *Master of Science in Geology*
Elizabeth Teresa Baruch, *Master of Science in Geology*
Gustavo Ernesto Diaz, *Master of Science in Geology*
Juan Guzman Rivera, *Master of Science in Geology*
Brian Stewart Harms, *Master of Science in Geology*
John T. Hull, Jr., *Master of Science in Geology*
Breanne Kennedy, *Master of Science in Geology*
Francey Natalia Leon Diaz, *Master of Science in Geology*
Andrea Antonietta Miceli Romero, *Master of Science in Geology*
Roderick Perez, *Master of Science in Geology*
Romina Marisa Portas Arroyal, *Master of Science in Geology*
Carlos Andres Santacruz Pantoja, *Master of Science in Geology*
Sipuikinene Miguel Angelo, *Master of Science in Geophysics*
Inyene A. Awakessien, *Master of Science in Geophysics*
Jessica Maria Pardo Taouil, *Master of Science in Geophysics*
Amanda N. Rondot, *Master of Science in Geophysics*
Carlos Fermin Russian Mendoza, *Master of Science in Geophysics*
Alice Stagner, *Master of Science in Geology*

ACADEMIC DISTINCTION

The University is honored to recognize undergraduate students who excel academically. Their performance is recognized by the University and the College by graduating with Academic Distinction.

WD - With Distinction
WSD - With Special Distinction

HONORS DISTINCTION

This is the most prestigious undergraduate degree designation at the University. These students complete both the requirements within their chosen major and the requirements of the Honors College.

CL - Cum Laude (With Honors)
MCL - Magna Cum Laude (With High Honors)
SCL - Summa Cum Laude (With Highest Honors)

BACHELOR DEGREES AWARDED

Bachelor of Science in Geology

Gregory Austin Alexander
Christopher Douglas Althoff
Jeffrey Manning Cook
Benjamin Shaw Davis
Lindsay Denise Guest
Bethany Carolyn Hogrefe
Maxwell James Hollman
William Jordan Myers
Justin Kyle Newman
Garrett Wade Reasnor
Brian Joseph Smith
Allison Renee Stumpf
Andrew Daniel Thiel
Tessa Loren Tidwell
Erich John Von Bargen
Steven James Wade

Bachelor of Science in Geophysics

Haitham Own M. Alsahfy
Mohammed Salih Altarooti, WD
Mansour Abdulwahed Alyahyay
Nicole D. McMahon, MCL
Aliya M. Urazimanova

2009 CANDIDATES FOR DEGREES

Seth Busetti, *Doctor of Philosophy in Geology*
Vincent Heesakkers, *Doctor of Philosophy in Geology*
Kelly Bischoff, *Master of Science in Geology*
Nicole Buckner, *Master of Science in Geology*
Nathan Cless, *Master of Science in Geology*
Gustavo Diaz, *Master of Science in Geology*
Angel Gonzalez Canro, *Master of Science in Geology*
Kevin Hathaway, *Master of Science in Geology*
Veronica Liceras, *Master of Science in Geology*
Erin Miller, *Master of Science in Geology*
Jessica Pack, *Master of Science in Geology*
Levi Pack, *Master of Science in Geology*
Victor Parra-Galvis, *Master of Science in Geology*
Kerry Paul, *Master of Science in Geology*
Jarred Tarkington, *Master of Science in Geology*
Julieta Vallejo, *Master of Science in Geology*
Thomas Ward, *Master of Science in Geology*
Catherine Cox, *Master of Science in Geophysics*

SEG STUDENT CHAPTER

ConocoPhillips School of Geology and Geophysics
The University of Oklahoma

2008—2009 OFFICERS

Victor Pena, President
Oswaldo Davogustto, Vice President
Elizabeth Baruch, Secretary
Yoryenys Del Moro, Treasurer
Dr. Roger Young, Faculty Advisor

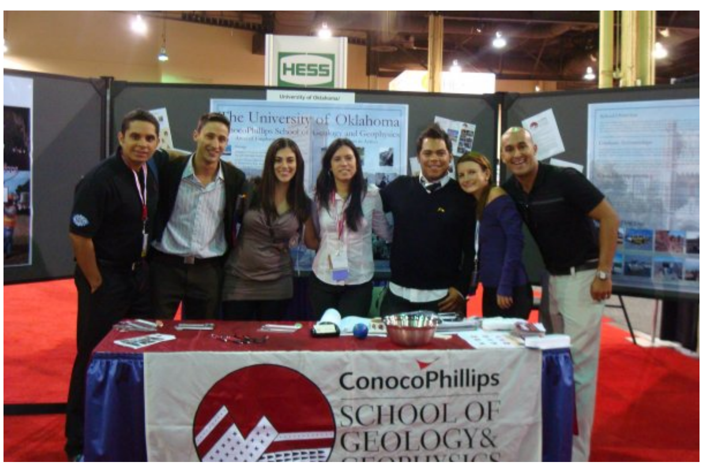
Year-End Report

Prepared by Victor Pena

As part of the tradition, the 2008-2009 academic year was rich in activities and recognitions for the University of Oklahoma's Society of Exploration Geophysics Student Chapter. This year's committee was composed of Victor Pena (President), Oswaldo Davogustto (Vice-President), Yoryenys Del Moro (Treasurer), Elizabeth Baruch (Secretary), Dr. Roger Young (Faculty Advisor), and Niki Chapin (Staff Advisor). Some of the main goals were to continue activities that had proven to be successful in the past, and to bring innovative ideas to enrich the chapter agenda.

One of the major activities during this year was the **78th SEG Annual Convention in Las Vegas,** where officers and members did their best to represent our university with enthusiasm and excitement. This year's budget allowed the student chapter to support over 20 students with flight tickets and hotel accommodations scholarships. All the awarded students were able to participate in short courses, workshops, technical talks, poster sections, networking activities, and recruiting interviews.

challenge bowl sub-committee on increasing the question database for future challenge bowls. The activity was divided into three main sections: the most questions asked on non-seismic (gravity and magnetic), the most questions on seismic, and the most questions on geology. A final award was given to the person who provided the most questions asked that combined the three categories. Every student had the opportunity to submit their questions within one week. Each question had to be sent with the correct answer, three wrong answers, and the source used to create the question. The winners were Supratik Sarkar with a total of 89 geology questions, Elizabeth Baruch with a total of 37 seismic questions, Ben Drenth with a total of 49 non-seismic questions, and Elizabeth Baruch with most questions overall. Due to the success of this event, the SEG staff asked us to write an article to motivate other chapters around the world to work on this kind of initiative to enrich our society events. For us, this event was a great success and we hope for the upcoming committee to include it again in the future.



2008 SEG Annual Convention booth: (l to r) Victor Pena, Carlos Russian, Jessica Pardo, Diana Parada, Xavier Refunjol, Romina Portas, and Roderick Perez

SEG Sooner Challenge Bowl winners: 1st Place (left) Brad Wallet and Oswaldo Davogustto; 2nd Place (right) Jonathan Funk and Jefferson Chang

Another important event was the **Raising Questions for the SEG Challenge Bowl Database**. This happened during November 2008 after having a number of conversations with the SEG staff, Peter Duncan, and some members of the challenge bowl sub-committee. This event was intended to support the SEG

In regards to the Challenge Bowl, the chapter was able to organize their **Second Internal Challenge Bowl Selection Round**. This year the event grew up a lot with a tremendous increase in questions and categories which created a game similar to the actual Challenge Bowl. The activity was able to have the presence of distinguished judges including Dr. Kurt Marfurt and Dr. Roger Slatt who provided their knowledge and ideas for the improvement of this event. From this contest, two teams were selected to represent OU during the Sooner SEG Challenge Bowl held during the AAPG/SEG Student Expo. The two teams were awarded with first and second place during the event allowing them to enter in the international SEG Challenge Bowl to be held during the next SEG Annual Meeting in Houston, Texas.

The **AAPG/SEG Spring Break Student Expo** was another memorable event where the chapter volunteered at some events including the first Kickoff Golf Tournament. The tournament was an absolute success, being able to create an environment of interaction between students and industry agents.

AAPG/SEG Spring Break Student Expo Kickoff Golf Tournament

Our field trip this year was to the **SEG Museum** located in Tulsa. This turned out to be a very nice activity for the chapter in which the SEG Staff prepared an amazing weekend for us. It started with an interesting tour around the SEG Museum, where students were able to see how exploration geophysics was done back in the day and how equipment and techniques have improved over the years. After that, we had a lunch and learned what new utilities were added to the PETRA software. The day ended with a geological field trip of the Tulsa area where students were able to collect some geologic souvenirs.

The **Geophysical Research Information Series at OU** came up with the idea of getting the entire geophysics faculty to speak about research interests, so students could have a better idea on what type of research they may do here at OU or how to complement their research. This year the chapter was able to host Dr. Kurt Marfurt who gave an interesting presentation on his research focus and his new goals for the upcoming years. We hope that upcoming officers keep this activity as part of their agenda.

SEG student members at the SEG Museum in Tulsa, Oklahoma

Last but not least, the chapter held **monthly meetings and movie nights**. The monthly meetings were key for the logistics on the different activities and also to brainstorm with members for new ideas. We were able to present movies such as "Black Gold" and "Reflections in the Field," where members were able to watch stories from our industry and explanations on how it works. Also, the chapter keeps an active presence at the Oklahoma City Geophysics Society. Here students are able to network with people from the industry based in Oklahoma, and to attend talks on cutting edge geophysical projects.

On behalf of 2008-2009 University of Oklahoma's Society of Exploration Geophysics Student Chapter committee, we want to thank the faculty, staff and sponsors for their help in making possible the accomplishments of these successful activities. We would like to give a special thanks to Dr. Roger Young and Niki Chapin for all their advice and help throughout this year; Dean Larry Grillot and Director Dr. Doug Elmore for the support provided with all the events; ConocoPhillips for providing us with the POLOs used for all our events; BP, Devon, UOSA, and the College of Earth and Energy, for their fund allocations and generous donations; Paradigm and CGG Veritas for the Student Membership Sponsor Program. We also would like to thank our members for their constant support for every event, and we hope the best for the upcoming committee.

JOIN

SEG Student Membership FREE

And gain these benefits:

- ***FREE*** monthly subscription to ***THE LEADING EDGE*** magazine (12 issues)
- ***FREE*** online access to ***THE LEADING EDGE*** magazine and ***GEOPHYSICS*** journal, current and archive issues
- ***FREE*** quarterly subscription to the student e-newsletter, ***the Anomaly***
- ***Scholarship*** opportunities
- ***Discounts*** on Continuing Education courses, workshops, publications, and SEG Annual Meeting registration
- ***Student Chapters*** at many Universities
- Transfer to ***Associate Membership*** and receive ***FREE*** dues upon graduation
- Developing ***professional contacts*** and ***industry ties***
- Increase opportunities in ***networking*** and guidance in ***career planning/development***

MORE INFORMATION:

Web site:
http://seg.org/students

Email:
students@seg.org

Phone:
+1.918.497.5574

HTTP://SEG.ORG/STUDENTS

Student Membership dues are generously sponsored by corporate supporters of SEG.

Society of Exploration Geophysicists
The international society of applied geophysics

AAPG STUDENT CHAPTER

ConocoPhillips School of Geology and Geophysics
The University of Oklahoma

2008—2009 OFFICERS

Carlos Santacruz, President
Austin Heape, Vice President
Andrea Miceli, Secretary
Byron Solarte, Treasurer
Dr. John Pigott, Faculty Advisor

Year-End Report

Prepared by Carlos Santacruz

What an exciting year we had! Several goals were accomplished, and a lot of recognition was given to our student chapter from people during the AAPG annual convention in Denver last May.

We did not receive the best U.S. student chapter award, but Austin, Byron, Andrea, all members, and I did the best we could to achieve it. In fact, AAPG expressed that we did not get it this year, but we are in the first position for next year." And my opinion of who would be currently in the lead for next year's award? The University of Oklahoma AAPG Student Chapter, who has submitted some excellent reports and has done some excellent activities" was expressed on AAPG Web page by Mike Mlynek.

That is why we have to keep this work up in the coming years. We will demonstrate that our university undoubtedly is a top institution worldwide.

I believe that we are different from other student chapters because of the creativity we have, and that was demonstrated in the different activities we organized last year.

The golf tournament integrated industry, academia, undergraduates and graduates on a cold, cloudy day, ending in fantastic results and drawing a large number of participants (more than 45 people including volunteers).

Group picture of the different golfers at the first SEG/AAPG Kickoff Golf Tournament.

The spring student expo in terms of organization and logistics was a smacking success. We had more than 40 volunteers setting everything up to support students, companies and our school.

The 2-day risk analysis course gave twenty of our members a different look at the industry.

The Risk Analysis course held by Henry Pettingill from Noble Energy.

An international videoconference in reservoir characterization promoted our university to three universities in Colombia. This activity shows that we can constructively impact more people beyond our campus. More than 80 people attended this conference held by Dr. Roger Slatt and organized by the OU-AAPG, OU Energy Institute of America, AAPG-SEG student chapters in the National University of Colombia, Industrial University and Eafit University.

The creation of the OU-AAPG Web page was the first step to organize our student chapter for the coming years. Now, it is time to promote it and for it to be used by our members.

At the AAPG annual convention our university was well represented by more than 23 students who helped at the OU booth. In a big effort we flew to Denver instead of driving, this motivated more people to come and to represent us.

These were just a few of the activities we organized last year. We know that our association is in good hands with the new officers, and they will be working hard to achieve our goals.

Many people and companies supported us last year. On behalf of OU-AAPG, I would like to thank Devon Energy, Shell, Schlumberger, Noble Energy, Yoana Walschap, Director of the Energy Institute of America at OU, Dr. Roger Slatt, Director of the Reservoir Characterization Institute at OU, Henry Pettingill, Bob Davis, Donna, Adrianne, Niki, Nancy, Teresa, and several companies that sponsored our golf tournament.

What a pleasure it was to organize different activities for you guys! We hope you enjoyed it, and we hope to see your involvement in the coming years. We are proud to be OU–AAPG Sooners.

Dr. Roger Slatt talking to 70 students in Colombia about reservoir characterization, along with Carlos Santacruz.

AWG STUDENT CHAPTER

ConocoPhillips School of Geology and Geophysics
The University of Oklahoma

2008—2009 OFFICERS

Rika Burr, President
Stacey Evans, Vice President
Sara Fadaiepour, Secretary
Alisan Templet, Treasurer
Dr. Megan Elwood Madden, Faculty Advisor

Year-End Report

Prepared by Rika Burr, Chapter President

The Sooner Chapter for the Association for Women Geoscientists re-established itself as a geoscience club the past two years after being on hiatus for several years. Though membership is still a bit low, morale and enthusiasm are high. Despite the misconception that membership is limited only to women, the Sooner Chapter more than doubled membership from the previous year, with the ratio of women to men of approximately four to one.

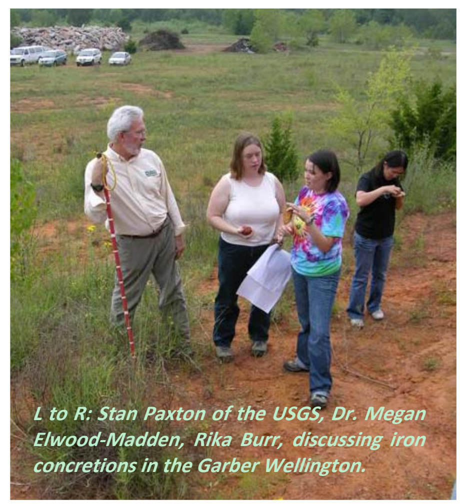
Kathy Benison and students in the Glass Mountains examining soil profiles to look at extremely acid saline paleoenvironments.

AWG started the year off with a visit from Dr. Marjorie Chan from the University of Utah to present her research on iron concretions and their extraterrestrial analog on Mars for the Shell Colloquium Series. Following the lecture, several members of AWG, along with Stan Paxton (USGS), Carol Becker (USGS), Julie Chan (OGS) and Neil Suneson (OGS) took a short field trip examining iron concretions found within Garber-Wellington exposures in the Edmond-Arcadia area.

Throughout the rest of the year, AWG members had dinners with subsequent female Colloquium speakers to discuss experiences and opinions on challenges and opportunities for women geoscientists. Speakers include: Jennifer Jackson from CalTech, Suzanne Anderson from University of Colorado Boulder, and Kathy Venison from Central Michigan University.

Further, AWG officers volunteered at a Women in Science conference sponsored by NASA/EPSCoR at the Omniplex in Oklahoma City. The conference was geared toward teenage girls who were interested in pursuing careers in scientific fields. Girls were given the opportunity to interact with female scientists through seminars, forums, and hands-on experiments run by female college students which helped the girls to get a glimpse of how to apply the scientific method.

Though numbers are few, AWG has become a close-knit group. Informal activities such as miniature golf at Perfect Swing has helped develop a healthy camaraderie between fellow members. With this solidarity, AWG hopes to start the next fall with new goals and ideas as to where the club will go.



L to R: Stan Paxton of the USGS, Dr. Megan Elwood-Madden, Rika Burr, discussing iron concretions in the Garber Wellington.

Kathy Benison and full group of students in the Glass Mountains.

Alumni Corner *2009*

AAC members at the Joint Board Meeting on November 16, 2006

Alumni Advisory Council

Know Your Council Members

(Executive Council highlighted in red)

Gerald R. Allen
Robert W. Allen
Jim Anderson
Tommy H. Atkins
Carlos "Tex" Bahamon
J. Denny Bartell
A.E. "Al" Basinger, Jr.
Doug Bellis
Edward "Ted" Benson
Orville "Roger" Berg
Brad Biddy
Angela M. Blumstein
Raleigh Blumstein
Charlie Bolt
Gabriel Borges
David G. Campbell
Kelvin D. Cates
James W. Caylor
Chris J. Cheatwood
David Childers
Patrick H. Clare
William W. Clopine
Robert Cook
T.D. "Tommy" Craighead
Stanley L. Cunningham
Bob Davis
Thomas E. Davis
John DeLaughter
Rodger "Tim" Denison
John R. Dewey
Joe D. Dischinger
Marlan Downey
Dan Earl Duggan
Mica Feinstein
Dave Fleming
Douglas Freeman
James A. Gibbs
M. Charles Gilbert
R. Vance Hall
Harold Hanke
Joe Hayden
Gene Heape
Gerald Heinzelmann, Jr.
Owen Hopkins
Mike Jobe
Jeff Kelley
Claren Kidd
Robert E. Klabzuba
Eric Kubera
L.C. Lawyer
Mark Leach
Emmitt S. Lockard
Robert Lord
Dr. Patrice Nsoga Mahob
Donald R. Massad
Jerry Glen McCaskill, Jr.
J. James McKenny
Cameron R. McLain
John B. McNeely
Gerard J. Medina
Galen Miller
Kate D. Moore
Kerry M. Moreland
Clayton Nichols
Charles "Chuck" Noll, Jr.
Brian E. O'Brien
H.W. "Dub" Peace II
Hugh W. Peace
Jeanne Polk
Randel Polk
Michael Anthony Pollok
Bill K. Reed
Robert W. Richter
Joe Rison
Suzanne M. Rogers
Aaron Rothfolk
Tom L. Rowland
Deborah K. Sacrey
Daniel Samake
Lealon L. Sargent
Dr. Douglas J. Schultz
William R. Siard
Roger M. Slatt
Gary S. Steffens
Robert L. Stephenson
Gary C. Stewart
John A. Taylor
John B. "Jack" Thomas
Dr. Matthew W. Totten
Gene Van Dyke
Joe T. Vaughn
Cyril Wagner, Jr.
Patrick O. Williams
Jon R. Withrow
Sharon Woods

OFFICERS 2009-2010

CHAIR
Mike Pollok

VICE-CHAIR
Kerry Moreland

SECRETARY
Sharon Woods

DIRECTORS

Joe Vaughn
Jerry Medina
Kate Moore
Harold Hanke
Tommy Craighead

NEW COMMITTEES

- OU Alumni Worldwide
  Chair: Patrice Mahob
- OK Geological Survey
  Chair: Vance Hall
- Alumni Communication
  Chair: Emmitt Lockard
- Gifts & Endowments
  Chair: Sharon Woods
- Industry Contact
  Chair: Dave Childers
- Curricula Development
  Chair: Roger Berg

If you would like to nominate someone to serve on the AAC Board, please contact ***Mike Pollok,*** *MAPEXPL@aol.com.*

Bill Reed
Bob Davis
Dave Campbell
Roger Slatt

The Lunch Club

Article scribed by
Roger M. Slatt

ROGER SLATT

It is my good fortune to occasionally be invited to join The Lunch Club, which is comprised of three individuals with very different backgrounds, but which have one thing in common---their love of OU, and especially the School of Geology and Geophysics. These three supporters are **Bill Reed, Bob Davis,** and **Dave Campbell**, and it is truly a joy to share a meal with them when possible. Below, I provide you with a bit of detail on why I say Bill, Bob and Dave are each unique, but when together, they certainly encompass the full range of professional, social, and political wisdom.

Roger M. Slatt
Ward Chair Professor and Director,
Institute of Reservoir Characterization
ConocoPhillips School of Geology and Geophysics

BILL REED

BILL REED is a native of Altus, Oklahoma. In college, first at Oklahoma Baptist University, then later at OU, where he was a Beta Theta Pi, Bill was a track and football player. Samedan Oil Company sponsored his studies at OU, where he received an M.S. degree, which was later published by The American Association of Petroleum Geologists (v. II, 1958, pp. 127-141. His thesis, on the Pre-Atokan unconformity in southern Oklahoma, is regarded as the first to suggest that the Viola Limestone was fractured, and that oil could be recovered from it (prior to that time, it was believed that only fractured sandstones could produce oil); a suggestion that was later proven with the drill-bit. During Bill's senior year at OU, he was voted the Outstanding Student and was the recipient of the prestigious Humble Oil (now ExxonMobil) Scholarship. Bill actually graduated from OU without any student debt, something that seems to be no longer possible!! Upon completing his M.S. degree, he worked first as a geologist for Standard Oil of California in Ventura, California, and then in 1968, he and his young family transferred to Oklahoma City with Standard Oil. His first couple of years were rough, with the family's moving truck burning up upon arrival in Oklahoma City, followed by the April 1970 tornado, which forced them to move until the damage was repaired. In 1973, he stepped out on his own and formed Akita Co. (Cherokee for "To Seek"), which later merged with Holden to form Holden Energy. In 1999, he formed his own company, called 'Viola", named for the formation which brought him drilling success. His other company is named Bromide (bromideinc@sbcglobal.net).

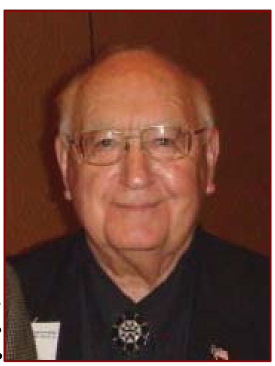
Bill has always been a contributor---with ideas, time, and donations--—to OU and the CP School of Geology and Geophysics. For example, in 2008, the Bill K. and Doann Reed Fellowship Fund was established with a substantial donation; the fund is designed to support graduate students from Oklahoma. Among his other activities, Bill was one of the "Founders" of Sarkeys Energy Center. When it opened, he and two colleagues (Paul Diehl from Penn State and Kenny Kemp from Schlumberger) taught courses in petroleum geology and well log interpretation. Even after leaving the lecture podium, Bill has always been actively involved with the CP School of Geology and Geophysics. He served as interim Director in 1989-90, Chaired the Alumni Advisory Council during 1996-97, and is an OU Associate. Bill's son, Kirk, is also a graduate of the School. In recent years, Bill has become a bit less visible than in earlier years, but I am aware that he retains his keen interest in the School and is always looking out for our interests from behind the scenes.

BOB DAVIS

BOB DAVIS, a relative newcomer to the School's friends, remains very much in the forefront of activities, and is a true (and official) Schlumberger ambassador to OU. There, he holds one of the highest technical positions, *Scientific Advisor and Geology Domain Career Leader.* In that capacity, he is responsible for the training and development of all geology personnel within the global Schlumberger network. His love of OU stems from his college days to his graduation in 1971 with a B.S. in Aerospace Engineering. Fortunately for the geoscience community, times were tough in the aerospace industry in 1971, so he joined Schlumberger, where he has spent the last 32 years. During that time, he held a variety of positions including Senior Field Engineer, Bradford, PA District Manager of Wireline Services, Senior Sales Engineer, Division Geologist, Interpretation Support Manager and Oilfield Services Solutions Manager. His technical specialty is borehole image analysis, which he helped develop and refine during his career at Schlumberger. In 2006, he and his family returned to Oklahoma to settle down, and have since built an 'active retirement home' in Norman.

It is not uncommon to see Bob hanging out in the School, where he has become a good friend and mentor, and sometimes employer, of our students, as well as students in the Petroleum Engineering School. He gives lectures on wireline log interpretation, usually accompanied with pizza for the class. He organizes a Schlumberger Educational Program during the AAPG/SEG Spring Break Student Expo, he formally (and informally) recruits students for Schlumberger employment, and often sits in on thesis defenses. His successful effort to provide a major grant of computers and Petrel™ software from Schlumberger to the School (as well as to the PE School), has allowed us to construct a first-rate computing laboratory for our students which is second to none, and which has allowed the school to make a quantum leap forward in our ability to educate students (and faculty) in advanced computing capabilities for hydrocarbon exploration and development. Such education is essential for our students to be not only competitive in the petroleum employment market, but to be 'ahead of the pack'. This contribution has major impact for the School and will be beneficial for many years to come. Finally, although Bob claims to shy away from technical writing, his resume contains a lengthy list of internal and external publications on wireline logging, with emphasis on borehole image log analysis.

DAVE CAMPBELL



The third member of the club, **DAVE CAMPBELL**, has been referred to in past Earth Scientists as the Energizer Bunny, and that is certainly true. I first heard the term "Sweat Equity" from Dave, and he really taught me what it means. Dave puts his heart and soul into every effort involving OU, from getting on the dance floor with our students to herding judges for the annual AAPG/SEG Spring Break Expo student poster competition. A native of Oklahoma City, he received his B.S. degree from University of Tulsa, and M.S. in geology from OU in 1957. His petroleum industry career has led him through Lone Star Producing Company, Tenneco Oil, and Leede Exploration. In 1980, he formed his own company, Earthhawk Exploration. Dave has been active on the Alumni Advisory Council for the School since 1983, serving on several subcommittees and chairing the group in 1992-93. He is also a member of the OU President's Associates. Besides his activities with OU, he has been very active with AAPG for many years, including Vice President in 1990-91, recipient of the Distinguished Service Award and Honorary Membership. He also is active in numerous other professional societies. A full listing of his many activities is provided in the 2005 Earth Scientist.

If one word were to describe Dave's outlook on life and OU, that word would certainly be "service", with "dedication" running a close second. His warm and friendly smile lights up any room, and his energy seems boundless. He is a true mentor and a person to be respected and admired. The Cherokee word for thank you is Wa Do, and we certainly say that to Dave.

So, again, I feel honored to be included in this wise and astute group. Not only do I exchange ideas, but I listen carefully and learn much during those lunch hours. They are a real treat for which I am grateful!!

LUNCH CLUB (minus 1) - Dave, Roger, and Bob

MARLAN W. DOWNEY

Alumnus Profile

Written by Roger M. Slatt

Marlan W. Downey is the recent recipient of the AAPG Sidney Powers Award, the highest honor offered by AAPG. It is just one of the many, many honors and awards that Marlan has gathered during his years in the petroleum industry. Marlan and his accomplishments are legendary!!!

I personally met Marlan in the mid-1990s, when he was president of ARCO International Oil and Gas Co. I was Manager of Reservoir Evaluation at the time. It was truly a pleasure and a constant learning experience working under the tutelage of Marlan. For the President of a major integrated oil and gas company, I was amazed to find that he spent much of his time at annual AAPG Conventions at the technical poster and oral sessions, keeping abreast of new technologies and exploration areas. At the office, he had a unique way of getting people to work harder, smarter, and more efficiently just by smiling and saying a few encouraging words. In fact, Marlan is well known for his brevity of discussion…………and I suspect his motto is "Actions speak louder than words." He was far and above the best person I ever had the honor of working for!!

Marlan is also a long and valued friend of the School of Geology and Geophysics and was voted in as an honorary lifetime member of the Alumni Advisory Council. During 1997-2000, he volunteered to serve as Bartell Professor of Geology and Chief Scientist of Sarkeys Energy Center. This was a time when the school was transitioning to, once again, fill a long-held niche as a first-rate petroleum geoscience academic department. He was instrumental in accomplishing this goal by teaching, research, and strengthening ties to the petroleum industry. For his efforts, he was named an honorary University of Oklahoma Alumnus and received a Distinguished Alumni and Service Award at a ceremonial dinner held on November 21, 2008.

A portion of the following is an excerpt from the awards program that was prepared by Mewbourne College of Earth and Energy for the dinner:

"Marlan W. Downey received his Bachelor of Arts in chemistry from Peru State in 1952, after which he served in the U.S. Army. He later earned a Bachelor of Science and Master of Science in geology from the University of Nebraska and a Doctor of Philosophy in science from Peru State.

Marlan joined Shell Oil in 1957 and retired in 1987 as President of Pecten (Shell) International. He founded Roxanne Oil in 1987 and joined ARCO in 1990, from which he retired in 1997 as president of ARCO International. In 2000, after serving at the University of Oklahoma, he was elected president of the AAPG (American Association of Petroleum Geologists). He is also an elected Fellow of the American Association for the Advancement of Science, a Fellow of the Geological Society of London, an honorary member of the AAPG, and a member of SEG (Society of Exploration Geophysicists). In 1987, Marlan was decorated by the government of Cameroon—the first businessman to be so honored. He has received the R.H. Dott award for best AAPG publication, the Hedberg Medal for his achievements in international energy, and was made an honorary University of Oklahoma Alumnus. He has been recognized as a *Legendary Explorer* by the Petroleum History Foundation and as *A Living Legend in the Oil Business* by the Houston Geological Society.

Marlan has served on the boards of numerous charitable foundations and universities, is currently a trustee of the AAPG Foundation, and serves on the boards of Object Reservoir and Foundation Energy. He is an advisor to the board of Matador Resources and is still active as the chairman of Roxanne Oil.

Marlan receiving his Distinguished Award from Kim Hatfield.

RODGER E. DENISON

ALUMNUS PROFILE

Written by
M. Charles Gilbert

OU has many illustrious alums whose contributions to geology, business, and OU are well known. This article highlights an OU alum who has tended to stay in the background but whose contributions to science, and to the School, are significant. **Rodger E. (Tim) Denison** is the kind of geologist and person many of us especially value. With a generous and gracious spirit, coupled with an astute geologic sense, professional interactions with him are both a joy and productive. Colleagues, like Ed Lidiak, Tom Rowland, and John Wickham, who have known Tim in a variety of roles and over a long time, praise their relationships with him.

Tim's family background provided the groundwork for his own outstanding career. His father, A. Rodger Denison, was born in Oklahoma Territory and graduated from OU with a BS in geology in 1921 and with an MS in 1925. The family eventually settled in the Hobart-Rocky area of southwestern Oklahoma, within sight of the Wichitas. During part of this time, he taught structure in the school, and worked for the OGS. Tim's father, who was a "Rodger," worked for Amerada for 40 years (1922-1962) until his death, rising to become one of the leaders of that company. During his early years at Amerada he interacted with Sidney Powers, Everette DeGolyer, and Dollie Rader Hall, three of petroleum geology's early dominant figures. Later, in the 1940s, Rodger Denison served as President of AAPG. He was a strong supporter of the School, and I can personally remember him giving a colloquium at the School in 1958-59. The elder Denison was enthusiastic about his sons developing careers in geology.

Tim graduated with a BS in geology in 1956, and an MS in 1958 under Cliff Merritt. The thesis was on the basement rocks of Stephens, Cotton, and Jefferson Counties. It involved working with rocks which came to be known as the Carlton Rhyolite Group. This unit is one of the most widely penetrated units in wells intersecting basement, just under the Reagan Sandstone, in southern and southwestern Oklahoma. It also outcrops in both the western Arbuckles (as Colbert Porphyry—East and West Timbered Hills) and the eastern Wichitas (Fort Sill, Blue Creek Canyon, Bally Mountain, Zodletone Mountain). Tim was employed then with the OGS (1958-60) and immediately began working with Bill Ham and Cliff Merritt on the fascinating and revealing basement story of southern Oklahoma. ". . . Bill assigned Tim to work on the southern interior (Texas, Oklahoma, southern Kansas, Missouri, Tennessee, Kentucky), and he assigned me the northern interior (northern Kansas, Nebraska, South Dakota, North Dakota, Iowa, Illinois, Indiana, Ohio). Bill filled in the areas not readily covered by Tim and me . . ." This work was published in 1964 as OGS Bulletin 95, still widely cited, because it provides the fundamental understanding of structure and basement rock types, and geological history of the southern Midcontinent. Subsequent to his time with the OGS, Tim went to the University of Texas to work on a PhD.

Unfortunately about this time, in 1962, his parents died in a plane crash. Tim and his sister, D'Ann, set up an account in the School in the 1960s to honor their father, the "Rodger Denison Fund in Structural Tectonics" for the support of graduate student research. (The account was carried in the school's general account for some years, but was set up in the OU Foundation by Director John Wickham in 1981). This endowed fund (OUF #40255) was early in the school's history of funds set up by alumni to help in teaching and research activities.

Tim's history at UT Austin is best summed up by Ed Lidiak, retired but still active at the University of Pittsburgh, in the following words: "I first met Tim Denison in the summer of 1962. We had both just been hired by Professor William R. Muehlberger . . . to participate in a study of the basement rocks in the continental interior of the United States. The U.S. Air Force, as part of the geophysical Vela Uniform Program, designed to detect and distinguish between underground nuclear explosions and naturally occurring earthquakes, funded the project …. Our main job was to make a buried basement rock map of the contiguous United States, primarily by studying subsurface basement rock samples (cores and cuttings) that were available in the sample libraries of various oil companies and state geological surveys and then attempting to correlate these results with available regional gravity and aeromagnetic maps. A cooperative project was also initiated with the Geochronology Branch of the U. S. Geological Survey (under the direction of Samuel S. Goldich) to carry out isotopic age studies to help understand basement geology.

"Tim was an especially excellent choice to work on the project as he previously completed a study of the basement rocks of southern Oklahoma . . . Tim was particularly helpful initially in explaining the methodology of sampling basement drill-hole cuttings, describing the samples megascopically and in thin section, and in interpreting the results on a regional basis. Tim, Bill, and I worked closely together through the completion of the basement synthesis, the writing of the final report, the preparation of the basement rock map, and the publication of the various scientific papers that followed. During all this time, and even later, I cannot recall a single example of a major disagreement among the three of us. We worked as a true team . . . What I do know is that it was a joy working with Bill and Tim. It was one of the highlights of my professional career."

[Tim completed his PhD at UT Austin with a dissertation on the basement rocks of northeast Oklahoma, subsequently published by the OGS as Circular 84 in 1981.]

Ed continues: "Tim and I continued to work together periodically on different basement rock projects after I went to the University of Pittsburgh . . . Tim also began mapping the Precambrian rocks of the eastern Arbuckle Mountains in the late 1960s . . . during the early 1980s one of my Ph.D. graduate students . . . and I were searching for an area . . . to] conduct a . . . study of Precambrian granites in the midcontinent region of the U.S. . . . Tim welcomed us to work in the Arbuckles with graciousness and enthusiasm. Tim gave us access to his unpublished field geologic maps of the eastern Arbuckles and spent considerable time in the field guiding us to critical Precambrian outcrops and in sharing his ideas on the Precambrian development of the southern midcontinent."

"Tim and I have worked together on different projects for nearly 50 years. He has always been and remains a highly trusted, competent, and honest colleague. Most of all, he has been a true friend."

After his time at UT Austin, Tim had several careers. First, he went to work at the Mobil Research Lab in Dallas and was there until it dissolved after the Exxon takeover. One of the School's former Directors, John Wickham, who left OU in 1984, also went to work at the Mobil Lab. John has commented on the important role Tim had at this facility. Tim was the geochemist responsible for the mass spectrometer and certain isotopic studies. One of the problems facing all workers in marine-deposited rocks is age determination. Where there are fossils, the problem is not so severe, but in some types, such as evaporites, there was little to go on except stratigraphic ordering. Tim and colleagues at Mobil developed the first systematic curve of Sr isotope variations in sea water through the Phanerozoic. Because they showed there are real Sr isotopic variations with time enabled estimates of age to be made on almost any marine-laid deposits, something not easily possible before. This had enormous practical applications in oil and gas exploration as well in understanding geological history of the Earth.

During his time at Mobil, Tim continued, and did extra, research on the basement rocks of the Midcontinent, particularly in Oklahoma. He undertook the first detailed mapping of the 1.37-39 Ga basement rocks exposed in the eastern Arbuckles. These are the oldest rocks in Oklahoma and define the "southern" edge of Laurentia in the Middle Proterozoic. He is responsible for the nomenclature now used for these rocks. [See the remarks of Ed Lidiak earlier.] When the Mobil lab was disbanded, Tim was instrumental in seeing that their isotopic facility was saved by its being moved to UT Dallas. He became a research scientist on the faculty there and has been able to keep some significant research going.

When I started working again on the Wichitas in 1977 for the Oklahoma Geological Survey (on sabbatical from Virginia Tech), and on what we now call the Southern Oklahoma Aulacogen, Tim was very helpful in sharing data from his earlier work. We have continued to have very fruitful interactions on the Wichita Mountains area and its history. We do not always agree, but the arguments made and advocated have helped build stronger, well-thought-out positions.

Tim has freely interacted with others working on the basement rocks of Texas, New Mexico, and Oklahoma. Melanie Barnes of Texas Tech has spearheaded new studies of the west Texas and Texas Panhandle basement. During these studies, she sought out Tim's comments on possible interpretations. As always, she had a willing and enthusiastic person.

John Wickham, and separately Tom Rowland, collaborators with Tim on field trips in the Arbuckles often involving Pennsylvanian tectonics, have noted that the success of these various trips came because of the way different points of view on the structure were able to be presented and appreciated. John also said that Tim always seemed to know where the good Mexican restaurants were. Tom says that the most astute geological minds he has known were Bill Ham and Tom Amsden, and still knows, is Tim Denison.

Tim's career has not only involved time employed by the majors, but he has worked for himself as a consultant. This has made him an invaluable member of the School's Alumni Advisory Council. He has been able to bring the viewpoints of the true scientist, the company person, the surviving independent, the academic collaborator, and perhaps most interestingly, as an alum of two strong but competing programs--Oklahoma and Texas-- to bear on issues related to how our school should function. During my time as Director, I always wanted to know Tim's views on how we were proceeding. We have in Rodger E. (Tim) Denison the kind of alum for which our school can truly be proud.

*L to R: **Tim Denison**, Tom Rowland, Mike Pollok, and Chuck Noll at the AAC luncheon during the Spring 2005 meeting.*

LETTER FROM MIKE POLLOK, AAC PRESIDENT

Dear Alumni and Colleagues:

When I was a student at OU, I lacked the knowledge of what it would take to become gainfully employed in the industry. Conversations with OU students today let me know that they share the same sentiment. I was taught, and students continue to be taught, that if we make good grades and perform basic extra curricular activities that an internship, interview, and job offer of $100,000+ annually will be available. This happens during times of plenty approximately one time in a 20-year span. But what happens the other 19 or so years?

I propose that each CPSGG alumnus writes a brief history of how YOU became a geologist or geophysicist after you graduated. I doubt that any of us did it the same way. I will compile a book of the information you submit and arrange for it to be presented to each CPSGG student before their job hunting endeavors begin. Perhaps to further enlighten the graduates, we might offer a series of colloquia wherein we could elaborate on our jobs as professional geologists.

We can all look back on how we got to where we are. It may not seem as if it is of any interest or benefit to others, but I suspect the students can, and will, learn from our joys . . . and sorrows. I hope by reading these exerpts from the book you will begin to see the vision and find out how YOU fit into the puzzle. I assure you that your story matters and will help make a difference in someone's future.

Scholarships and financial support are both well and good, but as the saying goes: "Give a man a fish, and he has a meal; but teach a man to fish, and he will never go hungry" (or something like that). This will be my passion for the next year as president of the Alumni Advisory Council. I intend to try and make it yours as well!

Ponder it! Submit your story to Jenmap1@aol.com.

Sincerely,

Mike Pollok

Mike Pollok
Graduate 1986

***Editor's Note**: The following pages are some of the heart-felt stories that have been submitted to Mike for his book. Enjoy!*

Mike Pollok | **1986 Graduate**

"AN OU GEOLOGIST BECOMING AN INDEPENDENT"

I was raised in Tulsa, Oklahoma, the second son of a German immigrant who had been employed by Skelly Oil as a draftsman. I played sports in high school, threw newspapers (mornings and evenings) and always worked summers. I developed a good work ethic. I went to junior college on a sports scholarship, and after two years, decided manual labor was better than school. After a year and a half of work, I decided school seemed an even better idea than being 40 and broke-down. I enrolled at OU in the undergraduate department in Petroleum Geology. I struggled for four more years to finally get a B.S. degree in Geology in 1986. The timing was perfect — no jobs. I also was not the best student with a GPA in the 2.75 range. Through school I had worked at a liquor store at night and had a lawn service during the summer. I knew how to work, but I knew nothing about petroleum geology or the oil business. During my senior year at OU, Schlumberger was the only company to interview on campus. This was for an overseas job, and during the interview, they informed me that they were only looking for degreed masters students. Due to word of mouth, with school chums, I finally secured a job with Dwight's Energy Data as an Oil Scout. This was no more than a data entry position and I was miserable. Ten months later I was having a beer with an old field camp pal, who was working on his Masters Degree and also working part time for a small independent, Jack Exploration, with an office in Norman. He stated the company was looking for a geotech, but that the tech could also generate prospects when all other work was done. The starting contract salary was $5 per hour with the understanding that I would pursue my Master's Degree. I accepted the position and went to work and classes. My work schedule could be flexible so I could attend classes. I worked 40 hours a week and attended at least three graduate classes per semester. At this time, I also married my lovely bride, Teresa. She worked for an attorney and had health benefits that really helped to secure our survival. My duties at Jack included geo-teching, copying, filing, land work, engineering, clerical and secretarial duties. I was not doing glamorous work, but it all taught me something of value later. I also was given the opportunity to do regional mapping on mylar maps. All my regional maps had the stateline of Oklahoma and Kansas in the middle. The idea being that Oklahoma geologists mapped north to the state line fault and Kansas geologists mapped south to the state line fault.

Jack Exploration liked to drill only wildcat ideas. James Jack's philosophy was look for traps with good reservoir rock. Mr. Jack was definitely an old school geologist. He knew what it was like to drill a dry hole. It was part of doing business. The industry in the early 1900s was run mostly by geologists or people willing to take a calculated risk. As long as all detail work was done, dry holes were accepted and part of the norm of doing business. He was able to convince his investors that as long as you were looking for large multi-well ideas cheaply that eventually you would "stumble into something". The only way to find something was through the drill bit. A good geologist understands this concept and is willing to stake his reputation to prove or disprove his idea. Most likely his idea is wrong, but as long as he had researched his idea to the fullest, no

Mike judging a poster at the 2009 Spring Break Student Expo at OU. Mike always volunteers to be one of our expert judges in the poster contest.

one can fault him for his effort. Wallace Pratt, another old timer, in 1952 wrote an AAPG article on the philosophy of oil finding. The following is a portion:

> *"Where oil is first found, in the final analysis, is in the minds of men. The undiscovered oil field exists only as an idea in the mind of some oil-finder. When no man any longer believes more oil is left to be found, no more oil fields will be discovered, but as long as a single oil-finder remains with a mental vision of a new oil field to cherish, along with the freedom and incentive to explore, just so long as new fields may continue to be discovered."*

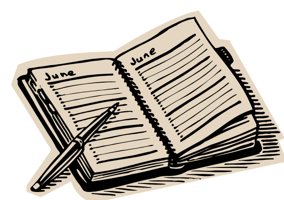
I think any geology student that wants to become an oil (mineral) finder needs to read AAPG's Treatise of Petroleum Geology, "Oil is First Found in the Mind" the Philosophy of Exploration. This is a compilation of an explorationist's thoughts and ideas through the 1900's. It is amazing how everything in the book is pushing oneself toward positive thinking. You can never find anything knowing that it is not there, or even thinking it might not be there……..prove it.

James Jack had made a gas discovery in northwest Woods County, Oklahoma in 1983. He battled pipelines for over two years along with drilling three more wells before he finally had the wells hooked up. This field to date has made 20 BCFG at 5,300 feet. Jack Exploration then proceeded to drill approximately 26 wildcat dry holes (a few of them mine) before making another discovery which will eventually produce 40 to 50 BCFG.

I took graduate classes that I felt would help me in generating prospects. The more graduate classes I took, the more I understood geologic concepts through electric logs and their subtle changes. I learned that flipping electric logs was the key to generating ideas. I spent hours and hours looking at logs. I remember wondering what all those curves meant. After two years of graduate course work (on probation) I was asked to leave school. I made a 1598 and needed a 1600 on my GRE to enter OU's graduate program. The politics of a university are unbelievable. OU at this time had fewer than 20 total grad students and 20 undergrads. At the same time I was promoted to a retainered geologist with an $1800 per month retainer, plus well-site work. I also had my first wildcat drilled and plugged. I proceeded to drill and plug approximately six more wildcat ideas before I finally made two back-to-back discoveries in 1992. Of these two discoveries, only one proved to be economic, at least at that time. These two discoveries gave me my first taste of overrides and mailbox money. I kept generating prospects both large and small. The more wells I drilled the more ideas I generated. As I kept looking at logs I learned what was "pay" and what was not. I learned there were many wells plugged during the boom that had "pay" in them. Jack Exploration did not like to re-enter wells and let me peddle those ideas to outside people. I started packaging up re-entries and selling them for cash, over-ride and some sort of working interest. My well interests and percentages slowly increased and I became more independent. As I grew, Jack Exploration was slowing down and did not want to do as much as I wanted to. He liked to drill two wildcat deals a year, and I was generating a lot more than that. I made sure we parted on good terms and eventually purchased the log library and regional maps I had copied and accumulated.

In 1995, I opened my own office in Purcell and began generating prospects. I became a member of the Society of Independent Professional Earth Scientists (SIPES). The first few years I was not very active in the Society due to being located so far from Oklahoma City. I was acquainted more with national members than my own chapter. Eventually I became a board member on the National level of SIPES. This was a very fulfilling experience. I met many people that are the movers and shakers in the energy business. I made many contacts that have been useful and I expect will continue to be good for both parties. Some of my contacts are now investors in my projects.

I have become an expert in a certain geologic region and know the ins and outs of the entire process of getting a well drilled. This includes checking records, making decisions on leasing, packaging prospects, selling, well-site geology, overseeing completion and marketing of the product. I have learned to pick and choose who to sell my prospects. A good prospect in a bad operator's hands is a dry hole, usually a completed dry hole. Always be upfront about any idea. When you are dealing with more than one operator in a particular area, make sure they all know where their AMI (area of Mutual Interest) ends and another begins. Surround yourself with good competent people and make sure they ask questions and in return you ask questions. KEEP THE MIDDLEMEN AND PARASITES OUT! The business is too large to learn it all. Every well is different, and every well I drill I learn something new. Many of my ideas have been generated away from the office. I have been driving, in bed, in the shower, visiting with people, or just meditating and visualized a concept in a different way than I had been thinking about it. Always keep an open mind and don't be afraid to try something new. And remember:



LESS THAN 10% OF ALL PETROLEUM GEOLOGISTS WILL EVER FIND A BARREL OF OIL OR AN MCF OF GAS!!!!!!!!!

Why is this?

- An oil finder is a detail person.
- An oil finder is a risk taker.
- An oil finder is a salesman.
- An oil finder is a positive person.
- An oil finder is a visionary.
- An oil finder is a "what if" person.
- An oil finder thinks both inside and outside the box.
- An oil finder enjoys what he does; it is not work….it's fun!
- An oil finder lives his profession.

Being an independent allows you the opportunity to find oil your way…………don't be afraid to take it!

Mike

Tom Rowland | **1956 Graduate**

"ONE PATH TO BECOMING AN INDEPENDENT GEOLOGIST"

EARLY YEARS

As a youngster growing up on the east side of Oklahoma City in the 1940's, a number of wells were drilled in our area, which was part of the Oklahoma City Field. I was fascinated by these drilling operations and spent a lot of time asking the geologist that was watching the well how he knew where to drill, about the rocks he was observing, and numerous other aspects concerning the geologist's role in oil exploration. That is when I decided I wanted to be a geologist.

My parents taught me a good work ethic as I held different jobs throughout my teenage years. Upon graduation from high school, in 1952, I entered the University of Oklahoma with the intentions of getting a degree in Geology. After playing baseball at OU for a couple of years my grades were not the best so I decided I better concentrate on my school work. I worked in a boarding house for meals and finished my degree and graduated in June 1956. There were 125 geology graduates that year and most did not get employment in the oil and gas industry, as jobs were almost nonexistent owing to a down turn in exploration. I was lucky as I got a summer job with La Gloria Oil and Gas Company in their San Angelo, Texas office.

They were a fairly large Independent company with a main office in Corpus Christi, Texas. I was planning on entering graduate school to work on a master's degree in the fall so this job fit my schedule well. I graduated on a Sunday afternoon and rode a train that night to San Angelo, Texas. That morning they gave me a new company car and sent me to Denver City, Texas to watch a development well that was drilling to the Devonian dolomite. I would have been lost had I not rough necked for one summer, so I knew the interworkings of drilling a well and I had a subsurface geology mapping course and sample running course my senior year. I spent the remainder of the summer watching wells in Osage County, Oklahoma, and doing subsurface mapping in the office. Upon completion of the summer job I knew how an independent company operated and the duties of an independent geologist.

I entered OU Graduate School in the fall of 1958 and received a Master's in Geology in 1959. While in graduate school I taught a petrology lab.

ACADEMIC / RESEARCH YEARS

During my final year, while finishing my Master's Degree I joined the Oklahoma Geological Survey. I worked with Louise Jordan and we completed a State map, OGS Map GM-5 illustrating Pre-Pennsylvanian Rocks of Oklahoma. This project provided me the opportunity to become familiar with the Pre-Pennsylvanian subsurface of Oklahoma.

Upon finishing this project and receiving my Master's degree, I joined St. Clair Lime Company, located in Sallisaw, Oklahoma. They had a lime plant in Sallisaw and an underground limestone mine and crushing operation north of Marble City in northern Sequoyah County, mining Hunton limestone which in this area is a high calcium limestone of chemical grade quality. I was in charge of quality control, and exploration for low magnesium limestone. This involved examination of underground mine faces for dolomite and a coring program from the surface in order to facilitate the direction of the mining operation. I acquired a wealth of experience in the carbonate industrial mineral industry.

Tom at an Alumni Advisory Council meeting in November, 2008. He sits on the Executive Board for the Council.

Upon completion of the project for St. Clair Lime Company, I rejoined the Oklahoma Geological Survey in September of 1962. In September 1965, I enrolled in the Graduate School at OU in order to begin work toward a Ph.D. in Geology.

During my prior three years with the OGS I again worked with Louise Jordan and we completed OGS Map-9, Pre-Woodford Rocks in Oklahoma. Additionally I had the good fortune to work closely with two world class Geologists, William E. Ham and Thomas W. Amsden. I published extensively with Bill and especially Tom Amsden. Tom and I completed OGS Map GM-14 which delineated the Silurian and Lower Devonian strata in the subsurface of Oklahoma. We also renamed the Hunton Group rocks in the surface and subsurface of northeastern Oklahoma, OGS Bulletin 105, and published numerous other papers on Silurian and Devonian rocks. These three years added immensely to my geologic knowledge which was invaluable for my independent consulting years.

In 1969, I was appointed to the OGS Staff as I was completing my Ph.D. Dissertation. I decided to give academics and research another whirl, at least for a while. In 1970, I was appointed an additional position on the Graduate Faculty at OU. During my tenure at the Survey, I consulted in industrial minerals and oil and gas projects. Also, I directed Master's and Ph.D. students. I was a research geologist in charge of research projects and economic mineral evaluation of carbonate rock in Oklahoma and assisted in disseminating geologic information to the public. During all my years with the OGS, I gained valuable experience in surface and subsurface stratigraphic analysis, which provided me with a good background for my years as an independent. In January, 1975, I decided enough of academics and research, so I left the OGS to begin working in the oil and gas industry to fulfill my intentions to become an independent geologist.

OIL AND GAS INDUSTRY

I joined Michigan-Wisconsin Pipeline Company in their Oklahoma City district office. I wanted company experience in order to become familiar with many aspects of the industry including advanced open and cased hole logging techniques and any other aspects which could be of use as an independent. I completed an exploration project on upper Permian carbonates and then was assigned western Oklahoma and the Texas Panhandle area to explore for drilling prospects. I had, at times, 2 or 3 other geologists under my supervision.

In August 1977, I left the company and became an independent. I had a partial retainer with Darnell Drilling Company in Oklahoma City, until January, 1979. Then I was completely self-employed as an independent geological consultant. My first drilling prospect resulted in a Misener discovery in Payne County, Oklahoma. Another well was drilled, also a Misener producer, and both wells made in excess of 200,000 barrels of oil. I had a 2.75% overriding royalty on this prospect.

The second prospect I had drilled resulted in a Redfork Sand discovery in Kay County, Oklahoma. This prospect resulted in both Redfork and Mississippi Chat production, with a final total of 32 wells, no dry holes drilled. I had a 3.125% overriding royalty in this project. The project produced over 2,000,000 barrels of oil and 1 billion cubic of gas.

For the last 22 years, I have remained an independent. During this period I have worked many geologic units in various areas of the State of Oklahoma, mainly northwestern, north central, and northeastern, and east central. I have had numerous prospects drilled, both wildcats and development wells, some dry holes, but many producers. I have monitored about 250 wells from the geologic aspect which includes getting leases, picking drilling locations, well site geologist from start to casing point, making all the decisions necessary to get the well properly drilled. Once pipe is run and the well is ready for completion, I then would pick the formations and footages necessary to test the well for production.

The last 6 years I have been involved in east-central Oklahoma in the drilling of Hunton horizontal wells, which was a new experience. Every new project should be a learning experience that can enhance your ability to be a successful independent.

FINAL ANALYSIS

I traveled a somewhat different journey to become an independent as compared to others. My early years I had a taste of the independent situation followed by academia, research, etc., and finally to a full fledged independent geologist. Along this path all the experiences enriched my background for future endeavors.

If you desire to become an independent oil and gas finder, you must have an excellent imagination. You should do as much surface geology as you can, for this is the key to understanding subsurface geology and solving the problems arising in oil and gas exploration. Take all the subsurface courses your department offers, hopefully, this will include mapping, sample examination, stratigraphic analysis, and perhaps an engineering course that will teach you open-hole logging. This will give you a reasonably good foundation to become an independent.

After attaining your degree or degrees, I suggest you try employment with a fairly good size independent as this will afford you better training for your ultimate goal to become an independent rather than being employed with a major oil and gas company.

Once you have taken that leap to the independent arena, pick a rather large region to explore. Stay with this area and through regional mapping you will define drilling prospects. Learn all facets of putting together a prospect and choose good sound operators to drill your prospects. Believe in your prospect to the extent you are willing to take a working interest position. Never stop learning, as each well will be different than the previous. Learn to be a good salesman and do not be afraid to recommend a drilling deal. Do not be afraid to drill a dry hole because all of us have drilled them and will, most likely, continue do so in the future.

Above all, love what you are doing with a good work ethic, as finding oil and gas as an independent is very rewarding.

Suzanne M. Rogers | 1968 Graduate

THE LONG ROAD TO TODAY"

I graduated from the University of Oklahoma in 1968 with a degree in History having taken only one geology course. Over the next twelve years, I got married, had two kids and got a divorce. Having a history degree and no teaching certificate meant I had to find some other way to make a living. That was in 1980, during an oil boom. My father, a long time oilman, suggested that I learn to check records in county courthouses. He had someone who would teach me. I jumped at the chance as I had no desire to end up in a classroom, with or without a teaching certificate. I learned to check records and became a decent landman and title person. After three years, I went to work for my dad, who had his own operating company and survived the oil bust that came shortly thereafter.

As I learned more and more about the business and went on location with my dad for everything from drilling to a downhole pump change, I found that I was more and more interested in geology and operations. I made a quick trip to the OU Geosciences department in 1989 and visited with a professor about going back to school. I gave it a shot after a twenty-year absence and took one class. Needless to say the experience was a whole lot different as I was working, raising two children and was twenty years older. However, I was hooked. After that one semester, I started taking two classes a semester to get another Bachelor's degree.

I got my Bachelor in Geology in 1993 at the same time that my younger daughter graduated from high school. My goal at that point was to get my Master's degree before she graduated from college which I did in 1996. My dad passed away in 1996 just before I completed my Masters at OU. What was left of the operating part of the family business was sold, and I was a full-fledged independent geologist. I have used the skills learned from land work, operations, geology and putting deals together to stay employed in one capacity or another, including the last 12 years at what is now known as Sandstone Energy Acquisitions Corp. A contact that I had made years earlier resulted in an opportunity in 1997 and, as they say, the rest is history. I cannot put enough emphasis on having <u>many</u> contacts. On the side, I have formed my own little company which invests in drilling prospects as my policy of "hedging my bets."

Looking back over the last almost 30 years, I have to say that I have used all the skills I have acquired to make myself into someone of value to a small independent and to myself in running my own company. My best ideas pop up anywhere – early morning, late at night, driving, daydreaming, etc. Those ideas are a new way to look at a problem, a new solution or perhaps another way to map a formation. It's all a lot of fun, except for the dry holes! Make contacts, expand your skill sets, be creative in making a deal, and remember that there is always another way of looking at a prospect.

Bill Siard | 1949 Graduate

"MY GEOLOGICAL CAREER"

When I returned from overseas after WWII in 1946, I renewed my involvement in the oil business by joining a drilling crew on a well in the booming Velma Field east of Duncan, Oklahoma. My job was cut short when my father had a serious heart attack in June of 1946. I attended to him during the rest of the summer until he passed away in August. I mention this because my Dad was a pioneer oilman, coming to the oil fields of southern Oklahoma in 1921. With this heritage, I always knew that I would be in the oil business, but the thought of being a geologist never crossed my mind.

I resumed my college career at OU in the fall of 1946. That semester I took a course in Geology 1, and fell in love with the science and selected it as my major course of study. During this period, I married Belva, my life long love, and we had our first child about three months before I graduated in January of 1949.

In the summer of 1948, my Dad's old company started drilling on a lease belonging to my mother. Clare Smalley, the company geologist, knew I was studying geology and asked me if I would like to catch samples from the well and check them with a scope. I gladly accepted the offer. We watched the well get to almost 7000 feet with no shows of oil. Clare said, "I am going home for supper." "If nothing shows by the time I get back, we will plug the hole." About twenty minutes after he left, I caught some samples of a drill break and they smelled of oil. I had them circulate and went to contact Clare, only to discover he had gotten a severe cut while repairing an air conditioner and was in the hospital. So, I called out a drill stem tester to test the zone. The zone flowed 75 bopd and I thought the family's fortune was made. Unfortunately, both offsets to the discovery were dry. So I thought I had better complete my geology degree.

I was anxious to get out of school, so I carried 19 hours that final semester and taught a minerals lab, for which I earned $19 a month. Jobs were plentiful in those days. There were many companies interviewing students for jobs. I opted for Atlantic Refining Company. I was told to go to Dallas for an interview with Dow Hamm, a gracious man and a wonderful oil finder. He asked me if I had a preference of an area to start in. I told him anywhere but West Texas. He smiled and said, "Bill that's where we are sending you." I gulped and accepted the offer.

I spent the next 10 years in Midland, Texas. I was given a microscope and sent to our sample lab. I made sample logs there on our company drilling wells and other significant wells in the region. There were four of us new hires in the lab. We were guided at the start by Dana Secor, a mentor I was lucky to have. After six months of making sample logs, my office days ended. One day Dana came with car keys for a Plymouth and all of us were sent to the field as well site geologists. I was assigned to the South District and started sitting on wells in Ector County, Texas. I was watching as many as five wells at a time and as a rule put over 5,000 miles a month on my Plymouth. Later I worked on wildcat wells in Reagan County, Texas. I only had one assignment during this period when I watched just one well. This covered a period of almost 4 years when I was never home and lived for about three years in the Mustang Motel in Big Lake, Texas. During this period I did very little prospecting, but I did know rocks and reservoirs.

At that time Atlantic had a large block of acreage southeast of Midland. Tex Harvey had developed a multi-well field just south of Garden City, Texas from a zone called the Sprayberry. This was a zone of low permeability thin sands that depended on fracturing to produce oil. Most geologists wondered where the pay zones were. So…Atlantic decided to drill 3 wildcat wells at the same time on our large block of acreage in Reagan County and I was assigned to them. The plan was to core all of the Sprayberry interval in each of the wells. Once the coring started, I was very busy describing the hundreds of feet of core. They had a lot of vertical fracturing. Even more perplexing to me at the time was the intense deformation in thin sand and shale layers interspersed with zones of shale and siltstone with flat planar beds. I later came to realize that what I had observed were turbidite flows. I had observed my first "Bouma" sequence and didn't even know it. When I started sitting on these wells there was not another drilling rig observable from horizon to horizon. However, during my last week on these wells Sohio moved in 16 rigs south of us in one day and the Sprayberry boom was on!

Those early days led me to work for two other oil companies, two stabs at consulting and being an independent operator (an oxymoron if I ever heard one). Most of my subsequent years were spent in management and in geological research. I look back fondly on those early days, because West Texas was the only area that I worked where I had some concept of what the geology was really about.

As I look back over my career, I realized that my geological talents were modest, but that my ability to work with people was my best talent. I am very grateful to geology for exposing me to all the wonderful folk I have known in this profession.

Owen Hopkins | **1969 Graduate**

"GEOLOGY AND ME"

HOW I GOT INTO GEOLOGY

My parents did not have the opportunity to attend college, and I was always apprehensive of going myself. I picked the University of Oklahoma because Oklahoma was in the center of the country.

After almost flunking out my second semester--0.87 grade point, I went to my guidance counselor for advice. He showed me a listing of his students and their grade point averages, and he told me that I was not the caliber of student he advised. He recommended I go to a different counselor. That was disheartening, but the new counselor reviewed my high school grades and said "Well, you aren't a dummy." He suggested I take a variety of courses and maybe something would get my attention.

So, after barely being able to stay in school, I signed up for 18 hours – History of Art, Accounting, Invertebrate Zoology, English Literature, Geology, and Aviation (since my father was a pilot). I had never heard the word 'geology' but Dr. Harper's "Intro to Geology" class was so exciting and interesting that I started taking notes, going to class everyday, reading the book and passing my tests. I got my first A in college in Geology, B's in all the others, quadrupled my grade point to 3.65 and called by mother and told her, "I am going to be a Geologist!"

I watched the Chevron interviewer circle my F in calculus...and then draw a line down and circle the A in calculus a few semesters later. That example might be an indication of how I might do if I ever drilled a dry hole -- ***Learn from your mistakes.***

LESSON 1

"GET ADVICE FROM A HIGHER POWER AND DON'T GIVE UP!"

I visited Dr. Harper in November 2008 in Norman and told him my story--of course, he did not remember me, but I remembered him. My life changed at age 19 in his class. The study techniques I learned in Dr. Harper's class, I used in my other classes, and I ended up graduating in 4 years--even after my dismal start!

HOW I BECAME AN INDEPENDENT

Since I did not take any petroleum geology courses from the University of Oklahoma, I have had to learn the business 'on-the-job' from a variety of companies — Chevron, Holly Energy, Sexton Oil, Harkins and Company and Suemaur Exploration. As a consultant to Sexton Oil, I learned that I liked to focus on generating prospects and that I needed to eventually join with other oil business professionals and form our own company.

Major Oil Company
Chevron 1969-1977

After graduating with a BS in Geology from the University of Oklahoma, I was hired as a well-site geologist with Chevron. In that capacity, I had the opportunity to log many wells, both onshore and offshore Louisiana from Chevron's Lafayette office—we had to log, core and test these wells with little communication with the office. I was briefed on each log run by the geologist responsible for the well.

After getting my MS in Geology from Tulane University night school, I was transferred to offshore exploration in New Orleans. Those were exciting, hectic times getting ready for lease sales—getting maps prepared, approved by management and bids prepared and submitted for approval. Chevron was a large company--we had seven layers of management that had to approve our prospects. At one point, I became frustrated with the system and decided to talk to the Division Geologist, and he explained the system to me—"all prospects were annually risked and ranked within each district, and each district had a budget; so the money was allocated from the top down— to get a prospect approved, it had to be bigger and better than others in your district".

Some of what I learned at Chevron:

LESSON 2

- ***Get hired, get in the door, get in the system—then you can learn and move up in the ranks.***
- ***Companies will help with continuing education—it helps the company and you.***
- ***Bigger prospects get funded and drilled.***

Small Public Company
Holly Energy 1977—1980

I was recruited to work in Corpus Christi for Holly Energy from friends that had moved there from Chevron in Lafayette. It was a risk—I did not know anything about the geology of this area, did not know the rocks, did not know if I would be able to find any oil and gas over here, and on and on. But, I decided to do it. I reasoned that I could always go back and work for a major again—but I really did not want to look back on this opportunity in the future and regret that I did not give it a try. So I did. ***When you come to a crossroads in your life, take the harder path.***

The president and chairman of the board flew, in their private jet, to all of the district offices twice a month and expected to see new prospects. We presented them pencil-contoured maps and logs and they took or rejected the deals on the conference room table. And the definition of a prospect was one that was leasable and ready to drill. We had no partners in the deals—they did everything 100% Holly Energy. Every 3 months all the districts met in Dallas and the results of each district's quarterly results were shown on bar charts displaying wells drilled, gas produced, oil produced and money generated. If you did not keep your numbers up, you were out and replaced by someone who could.

Needless to say, this was a high-pressure job and was considerably different from Chevron and, of course, I never met the Chairman of Chevron.

This district office was very successful. We drilled a lot of wells--mostly development. We generated smaller sized prospects, and we usually found less oil and gas than we thought we would.

Small prospects find smaller reserves. There was a lot of effort, time and money spent; but we had to keep up the frantic pace to keep up the numbers.

But one year our number of wells drilled was up, but our gas and oil reserves were down by the 3rd quarter. But, our district manager had gotten approval to drill two higher potential and riskier prospects and one of them actually was a discovery in the last quarter of the year. This one large potential prospect discovery put us way over our quotas and we all expected very large bonuses based on the original verbal formula that we were working under. But management changed the rules in midstream—they decided they did not want to give that much money to the employees for fear that they would quit.

LESSON 3

"GET YOUR AGREEMENTS IN WRITING.

Consultant Geologist for Sexton Oil
June, 1980—January, 1987

Win Sexton (a local, well-known, very successful independent geologist) called me up and said "Meet me down in the *Valhalla*, I want to talk to you." He wanted to put me on a yearly retainer and give me a 2% Overriding Royalty on any prospect that I generated. He said he was an 'equal opportunity geologist'—because good prospects will sell no matter where they were, and he could sell any good prospect that I generated.

If Win liked the prospect, then it was a go. Win liked large prospects saying "It is **just as much trouble to lease a small one as a large potential one**—the big ones don't always work, but when they do, it is significant." But big prospects usually have minimal well control. **That is "what majors were for—to drill deep dry holes in the middle of nowhere"** and in the process their logs showed the deeper stratigraphy that we needed to decrease the risk of our wildcats.

The experience working for Win taught me not to be discouraged when working an area by the surface, land or lease situation. **Do your work, do the science and then let the merits of the prospect better define the economics of it—*Be positive from the beginning.***

We were so proud when we sold a downthrown fault prospect in Louisiana to Davis Oil for $1000 per acre. They proceeded to drill on the high side of the fault even though downthrown traps were working on trend and drilled a deep dry hole.

Another deal, sold to Mesa, was returned to us after they shot 4 seismic lines and told us there was no prospect. The contract terms required Mesa to return the deal to us (including the seismic) if they were not going to drill within a certain time frame. Then, with the new seismic and some remapping, we ultimately sold 22 hundred acres to Exxon for $1000 per acre (with a 25% BackIn After Payout and 72% net leases!) it drilled out to be a tremendous discovery in February 1986—3 wells produced 100 BCF of gas and 3 million barrels of oil.

LESSON 4

- ***When you sell a deal, retain some control of your prospect.***
- ***Have a good landman.***
- ***Don't be discouraged by others.***
- ***Believe in your own work, and DON'T GIVE UP!***

At Sexton Oil in the late 1980's, after the prospects were put together and brochured, we needed to sell 100% of each one we generated and that entailed a lot of traveling and my kids were 9 and 6. I remember a Southwest Airlines magazine ad in the late 80's that had a picture of a little girl looking out of a window of her home in the evening and the ad stated: *"We will get you on time to your most important meeting of the day—Home."*

I left Sexton Oil & Minerals to join Harkins & Company in early 1987.

Small Independent Co.– Harkins & Co.
February, 1987—December, 1989

I was hired to open a Corpus Christi district office for Harkins and Company. The seismic budget—get any lines you need! And the technique was to put the best prospects together in a trend. Harkins supported a regional mapping approach—map a trend, get to know it, get to know what works, get to know who is successful. ***Don't put the first closure you see together that you run across—put the best prospect together first.*** And like Chevron and Win Sexton, they wanted larger, higher potential prospects—minimum 25 BCF (billion cubic feet of gas).

Harkins allowed geologists time to do the regional work. That time often came when the oil and gas prices were low. My approach was to **work steady freddy** – don't be concerned with the current oil and gas prices, they will always be going up and down, but concentrate on the mapping and the science. Slow times are great opportune times to do mapping-phones don't ring and the library is quiet. ***Take advantage of slow times to get your mapping done.***

Harkins & Company always took 25% working interest in any project. But I always had to be ready for this question —*If this prospect is so good, why didn't Shell drill it? Good question.* Don't be frustrated with a question like this; sometimes we get so close to our deals that the answer to this question will really be a selling point of the prospect. **Run your ideas across others in your company—consider any and all comments**—you may hear them again when presenting to outside investors.

The great advantage at Harkins & Company was that they were spending their own money up front just like a potential investor would—this made it so much easier and better and faster to sell a prospect. **Make sure your company owns some working interest.**

In November 1989, the exploration division of Harkins & Company was sold to two geologists and an engineer. We changed the signs on the office door from Harkins & Company to Suemuar Exploration on January 1, 1990.

<u>Private Co.– Suemaur Exploration 1990—Present</u>

Suemaur has been able to drill prospects consistently through the years because we have had built-in partners who wanted to explore for oil and gas with us. What was so important to our explorationists was that our venture partners flew to Corpus Christi for exploration meetings — our exploration time was maximized by not having to travel to sell the prospects. **We did not have to travel to sell our prospects.** We had seismic budgets, drilling budgets, partners and money for one or two-year commitments – all we had to do was generate good exploration projects.

A few years into the venture we decided to sell some of our production. Once we had a made a new field discovery, our explorationists were spending time and energy and our engineers were spending time and energy on developing these fields. If we were truly an exploration company, selling started to make sense. We decided to sell our fields before they were completely developed – cash them out and spend our time and energy on exploration and let others spend the money and effort on development drilling. We found that others were willing to buy our partially developed fields and we had cash to spend on other exploration projects. **We are in the business to make money --**not to see how many wells or how much daily production we have.

In order to get more than just an overriding royalty, **the geologists began buying an interest in Suemaur with the cash generated from the sales of our production prospects**. The owners were willing to allow the employees to become owners in the company and have more of a financial stake —this was good for all the parties. We all pay our share of all expenses and receive our share of the profits and receive a cash call or a check each month.

Some of our venture partners 'cherry picked' our prospects and elected to participate in only the 'better' ones in a year and managed to drill dry holes and miss the discoveries in the prospects they declined to participate. If you have good explorationists working in good trends with good support and backing, then the discoveries will follow.

LESSON 5

"IN AN EXPLORATION EFFORT, JOIN IN ALL OF THE GENERATED PROSPECTS."

RETIREMENT

I retired from active oil/gas exploration in 2005 as Vice President of Suemaur Exploration--but remain as one of the owners of this very active south Texas independent oil/gas exploration company.

I am using the exploration techniques I used in the oil business in my new interest—education. In 2006, I was elected President of the Corpus Christi Geological Society and initiated our goal for 2006-2011, "Maps in Schools, Bones in Schools and Boulders in Schools", and I am having as much fun doing this as I did generating prospects and drilling wells. Except, now I don't have to wait until we get the leases before I can drill.

Verlan W. Harrell | **1959 Graduate**

"MY PATH TO INDEPENDENCE"

I grew up in NW Oklahoma on a farm where I got a taste of hard work as a kid. My dad was propane and butane distributor and, therefore, did not have time to do farm work. So, at an early age, I began working from daylight until dark, and sometimes longer, on the farm and was paid a commission on revenue and farming related production. I was over paid, I might add, but it instilled in me a love of money.

After graduating from high school in 1952, I received a scholarship from

Verlan

OSU, then Oklahoma A&M, to study engineering. I had decided, while riding a tractor all day long, that I wanted to be a building contractor. But, my dad, who did not go to college and my mother, who was a teacher, gave me some good advice. He said he would rather I not go to school at A&M, because I would end up getting inbred. He was correct, as I learned later. He was saying, the people you meet in college are more important than what you study, which turned out to be true.

Before the fall session commenced, I applied to Oklahoma University and received the same scholarship as a freshman. So, I enrolled at Oklahoma University in architectural engineering and continued in that curriculum for two years. A friend of mine was studying geological engineering and we had both come from NW Oklahoma farming areas. I became interested in geology and, I should add at his point, the thing that caused this interest was an article in the student newspaper. This article pointed out that geology graduates were some of the highest paid graduates from the University. This got my attention. So, I switched from architectural engineering to geology. Fortunately, some of the classes, such as drafting, surveying, etc. were transferable to the geology school. I stayed in the geology department and graduated in 1959.

After a tour of duty in the military, in White Sands, New Mexico, I came back to school with some thought of law school, but, after visiting with that department, I discovered that I would have to take a considerable number of prelaw courses that I didn't have. So, I applied to the geology graduate school which I could finish considerably faster than a law degree. I might add, at this time, that geology graduates found it very difficult to get a decent job and obviously were not close to being the highest paid graduate students from the University. Fortunately, I was offered a job with Conoco a short time before graduating. I got the Conoco job just working two afternoons a week while still in school doing more land work than geological work.

While taking a sub-surface geology class, where two students were assigned to work together, I met my partner who was from New Mexico and ultimately turned out to be a partner of mine in the real world. We were working on a project in Dr. Carl Moore's class. We were given a 9 township area in Oklahoma to map and write a report on as if we were presenting it to an exploration manager and recommend either acquiring acreage or condemning it. As we finished the project, we showed it to Dr. Moore, thinking he had already had it mapped numerous times. We wanted his opinion on any errors; because it appeared to us that there was a substantial structure that we had contoured in this prospective area. Dr. Moore agreed with us and indicated that this area never had been given to anyone prior to us. So, my partner and I decided we would raise a little money and lease the prospect and see if we could turn it. I must give my partner due credit, his family was in the oil and gas business in New Mexico and they acquired an interest in our prospect and recommended we show it to other investors and raise funds to drill a wildcat well on this property. At this time, we both decided that neither of us needed a job. Obviously, by signing an agreement with Conoco, it meant no prospecting on our own. So, I thanked them graciously and left.

In the meantime, I met a gentleman by the name of S.J. Sarkeys, an independent whom the current Energy Center is named after. He asked me if I was interested in working for him. I answered I would, but I would need time off in a couple of months to drill my well. He said, "Fine, but no pay for your time off." So, after drilling a dry hole, I came back with my head down and decided that I better concentrate on keeping my job. I should add that, unfortunately, I didn't finish my masters degree.

At this point, Mr. Sarkeys was a mineral and overriding royalty investor. He indicated that he had approximately 600,000 acres in undeveloped leases in the Anadarko Basin that needed to be developed. He called his attorney into our meeting and I was asked if I could spend a very large sum of money over a one year period on these various undeveloped lease blocks. I was just naïve enough that I replied "no problem." On the first block we drilled, our discovery well had a calculated open flow of 69MM CFPD and 3700 BPD condensate. The second well, some fifteen miles away, flowed naturally 18MM PD dry gas. I should probably add at this point that the tool pusher on each hole obviously knew I was extremely green, so I did whatever they said to do. We then drilled ourselves or farmed-out 17 straight producers, and I learned what carried interest meant. As in some wells, Mr. Sarkeys was carried for a one-half interest to the tanks.

As time marched on, he created a foundation and traveled and I very seldom saw him. He would call in to get daily reports. Upon his death, he left the bulk of his assets to his previously created foundation, of which I was a trustee, along with some other people. The Board of Directors of his corporation, upon his death, decided not to sell the corporation and made me the C.E.O. All stock of the corporation was owned by the Foundation; so we continued to develop the assets in the corporation, acquired a drilling company, trucking company and diversified into commercial real estate.

Unfortunately, or fortunately, whichever way you look at it, the IRS passed what was known as the 1969 Tax Reform Act. That particular move by the IRS ruled that a foundation couldn't own more than 20% stock in any corporation. I was instructed to check out the feasibility of taking the corporation public. In all cases the companies I contacted in New York said we were too small to do anything that the directors wanted to do. The foundation decided to sell stock as it was not paying dividends.

Then, by almost an accident, I met an attorney in Washington, D.C. He advised me of a provision for an employee buy back of corporate stock. As you would expect, it was a fairly complex, rigorous approach to be sure employees were giving the foundation a fair price for their stock. After considerable time and effort, we were able to arrange financing for the buy back. It now became an employee owned company, owned by eighty plus employees, all owning shares by a formula based on time with the company. It turned out that I had the single largest amount of shares, having been there the longest; 24% of the corporation. So, at this point, our entire mode of operations for the corporation had to change since we owed a substantial amount of money to banks on this acquisition.

With some degree of luck, about this same time, the price of crude oil and natural gas began to move. Oil was selling for $2.50 per barrel and gas at .15 per mcf. Due to the lack of funds and strict budgeting to pay off debt, we concentrated on a Pontotoc County, Oklahoma prospect. We found the productive zone at 3,500 ft. and ultimately drilled 25-30 wells on that property. We started looking for investment partners to drill in the Anadarko Basin to try to protect our leasehold. Our first major investor was Natomas N.A.

In 1979, still having substantial corporate debt, some shareholders wanted to go ahead and sell the company and ultimately made a deal and sold it to Sabine Corporation in Dallas, Texas.

At the time of the sale, five of the original shareholders and I formed two companies: Nova Energy Corporation and Nova Drilling Corporation. We then hand picked a few employees to bring along. From that point in time to the oil and gas debacle in 1982, we thought we could do no wrong. The price of petroleum products kept going up and up. In 1982, things started the other direction. We continued, like others, to pull in our wings. One of the partners died from a heart attack — actually, the one I started with in college. Another partner died from cancer. The remaining partners then decided to sell Nova Energy and Nova Drilling.

I worked strictly as an independent with investors over the next years until I bought Sensor Oil and Gas. I had been contacted by a group from Sensor Oil & Gas, which was owned by New York Life and John Hancock. Ultimately, I and three other people, made a deal to acquire that company. Sensor was a company similar to the original Sarkeys, but much larger by owning properties in seventeen states. Eventually, I bought out the other three partners and slimmed down operations by operating only in Oklahoma, New Mexico, Texas, Louisiana and Mississippi, consequently, reducing payroll drastically. I had no intention of disposing of Sensor until a group of people made me an offer. I decided then, at my age, it was time to accept and did so.

Since then, I have operated only through the company owned by myself, Harrell Petroleum, Inc., along with only two full-time employees with three other professionals leasing office space. I only participate with operators that I have dealt with in the past. I think, after rambling about the past, that to become an independent you have to have the desire to do things and make decisions on your own without waiting for instructions. You have to have the desire to have fun and enjoyment to succeed. The way to do that is to let your assets be your scoreboard. If you don't have these desires, you should not be an Independent. You should not be working and waiting for the time to retire. I learned this from both my father and from Mr. Sarkeys. At the age of 93, Mr. Sarkeys was still mentally active in his company's operations by keeping a close eye on what I was doing.

I might also give credit to the OU faculty, as numerous professors took a considerable amount of their time in trying to instill the idea of finding oil for myself.

As an example, one professor spent a whole day in paleontology class advising the class that he had worked for a major oil company out of college. He used his company car for a taxi at night up until the time he left the company. He then worked for himself and, upon retiring, went to work as a professor. After retiring as a professor, he was back to working on his own. Six or seven of my professors all worked for major oil companies at one time and all strongly recommended getting that experience yourself; then, that you think seriously about going out on your own. This is not meant as a slam against the major companies, but to say that you should use employment by them to gain experience to ultimately work for yourself and establish your own company. My university advisor urged me to take some courses in accounting and economics, advising that these courses would be valuable to me in my later business endeavors.

In closing, one of the most gratifying things about being an independent is the satisfaction of accomplishing your goals. There will be, of course, some disappointments and failures along the way, but that is what makes the achievement of the goals that much sweeter and worthwhile.

William W. Clopine | 1990 Graduate

"WHAT'S NEXT? WHO KNOWS!"

Bill Clopine, on the right, conversing with Emmitt Lockard at an AAC meeting.

I was born and raised in Redlands California, and took an interest in geology very early in life. My father, Gordon A. Clopine, an academic and independent consulting geologist, first introduced me to geology. I had many opportunities to go on geologic field trips, participate in classes, and assist on work sites. These personal experiences with some of the many options for a career in geology lead me to pursue a degree of my own. I am the first to admit I had no idea of the directions my career in geoscience would eventually lead, but I have always been happy with the choices and opportunities my geologic education provided.

I have always been interested in science, travel, and solving puzzles. Geology combines all of these, with the added opportunity to work with people of different backgrounds and cultures from all over the world.

There is no doubt that strong technical skills are required to be a successful Geoscientist. Skills can be focused as a specialist in a limited area of Geoscience or as a specialist in a specific geographic area. But, many elements of a successful career are not technical. Some of the most important things I learned in my academic career were attention to detail, maintaining multiple working hypotheses, meeting deadlines, listening carefully to advice and suggestions from faculty and other advisors, the importance of understanding the problem before providing a solution, and managing a group of people (like your thesis committee) to a desired outcome.

I earned a BS degree in geology from the University of Redlands in Redlands California in 1983. This program provided a good foundation for my technical skills. As a small college, most of the geoscience courses were taught by visiting faculty. I was able to experience geology from multiple points of view in an area where a very wide range of geology was accessible just a short drive from campus. The Department Chair, Dr. Stephen Dana, also had connections to the Petroleum Industry. He provided my first opportunity to visit a well site, visit an offshore installation, and attend my first AAPG meetings. All of these experiences were very valuable down the road.

I applied to the Graduate Program in Geology at the University of Oklahoma in 1983 and was accepted with a teaching assistantship. The assistantship was very valuable to me, and not just for the income. The teaching assistantship experience helped me master a wide range of topics I was introduced to in my undergraduate degree. It gave me my first experience working with Petroleum Engineers, improved my presentation skills, and a whole host of other experiences. While not necessary, I would strongly recommend that anyone wanting to be a professional geoscientist look for opportunities to teach as a very valuable step along the way. As teaching and learning often go hand in hand, it is also a process that has served me well my whole career. The year 1985 was a very difficult time in the Petroleum Industry. Geoscience jobs were scarce, and my best path forward was not at all clear. I had hoped to be employed in a full time position before getting married, but decided the boom and bust cycle of the Petroleum Industry had delayed me long enough. I married my beautiful wife in California on the summer break that year, and we returned to Norman so I could complete my MS degree and begin my professional career.

I was unsuccessful, however, in getting a job offer in the fall of 1985, and it was little comfort that I was not alone. At the same time, my thesis advisor, Dr. P.K. Sutherland, and I had worked up a very interesting PhD project in Southern New Mexico. This project was fully funded, my wife had a good job in Moore OK, and we enjoyed Norman and the University of Oklahoma. Thus adversity (no job) was turned into opportunity, and I jumped into the OU PhD program in Geology with enthusiasm. In my experience, being flexible and turning difficulties into opportunities, are important and often necessary components of a successful career in Geoscience!

As I neared the end of my PhD project in 1990, the job market was not much better, and I was not nearly as well prepared as I should have been. My advisor was not keen on the Petroleum Industry, and had discouraged me from taking any industry internships. As I started interviewing for full-time positions again, the scope of this mistake became more and more evident. Fortunately, Dr. John Pigott spoke on my behalf to the Geoscience Staffing Manager at Conoco, and in the summer of 1990 I was offered an internship in Conoco's Deep Water Exploration Group in Houston Texas. I will always be grateful to Dr. Pigott for this opportunity and start of my professional career as a Petroleum Geologist.

It is true that internships take time away from academic studies, fieldwork, and often families as well, but in my experience nothing provides better preparation for a successful career in the Petroleum Industry than the hands-on work experience of an Industry internship.

Following my internship with Conoco in Houston, I was offered a full time job as a Development Geologist in Conoco's Lafayette Division office in Lafayette Louisiana. This job meant living apart from my wife for almost a year as she completed her contract in Oklahoma. Having a set end date made this arrangement bearable.

In Lafayette, I was determined to learn everything there was about being a Professional Petroleum Geologist. The field I was working was discovered in the 1960's, and had been developed on 2D seismic data. My arrival coincided with a new 3D seismic survey, and this data brought significant new opportunities. My PhD had focused on carbonate petrology, stratigraphy, and biostratigraphy, but my job as a Development Geologist focused on Tertiary deep-water clastic systems. As our Geophysicists mapped the structures, I mapped out the depositional systems and reservoir fairways. It was great work, and remains one of the best jobs I ever had. I was able to learn offshore operations, represent the company at Partner meetings, and participate in numerous successful wells over a 4-year period. The lesson here is that the geographic location and the geologic setting would not have been my first choice, but the company needed me there, provided great resources, and I was able to learn and contribute in a significant way right from the start. This foundation has served me well in the rest of my career.

The Exploration Manager stopped by my office one afternoon in 1994 to see if I might be interested in a new position in a new group of Structural and Stratigraphic specialists forming in Houston. I was happy with my work and Lafayette, so after a short conversation we decided I would decline this opportunity. Two days later he returned and let me know the new position in Technology "may not have been as optional" as he first thought. So, once again, I jumped to a new job in Houston where the company needed me.

The irony here is that the biostratigraphic component of my PhD lead to this new position, even though it had essentially nothing to do with what they wanted me to do! Once again, I was determined to learn all I could and contribute to the Company in my new role as quickly as possible. Fortunately the professional networks I had developed both in Lafayette and in the biostratigraphic community during my University degrees served me well. Over the next 3 years I defined and expanded my role, and built the roots of a program that remains in place today.

I was ready to get back to Exploration or Development Geoscience after 3 years as a biostratigraphic specialist in Technology. I spoke with my supervisor, networked with company contacts, and after a few months was offered a position in Conoco's Atlantic Margin Exploration Group in Aberdeen Scotland. This was a fantastic opportunity both for the cultural experience of living overseas, and for the work. My wife and I enjoyed every bit of the experience. I would recommend an overseas assignment to anyone that is open to a change in just about everything.

In some regards the technical work of developing a large scale Exploration Play in a frontier area was vastly different than my Development Geologist role in Lafayette, but quite similar in others. Ultimately we were not commercially successful, and that's the bottom line for an industry geoscientist. With oil prices falling to nearly $10 a barrel in 1999, it was time to return to the United States. To my surprise, the opportunity for me back in the U.S. was in a supervisory position in Conoco's Houston based Technology Group.

Being a Supervisor offers a whole new set of challenges that being an individual contributor does not. Once again I had to learn a whole new set of skills, plus earning the respect and trust of my colleagues and direct reports. Fortunately my group was staffed with an excellent team of technical specialists. We worked together and had a big impact on the company on several key projects. I did my best to continue learning and keep my technical skills current, but I expected that my career path was now set. In this, I was completely wrong.

Along with the rise and fall in oil and gas prices, mergers and acquisitions are a significant and unpredictable element of a career as a Petroleum Geoscientist. When Conoco Inc and Phillips Petroleum merged in 2002, I returned to a technical role as an Exploration Geologist. This change was unexpected, but not unwelcome. It turned out to be a very good decision to keep my technical skills as a geoscientist current, and I was able to quickly contribute on a variety of exploration projects around the world. My love of travel was put to the test on projects in Asia, South America and Europe. Projects ranged from short term "quick look" screening studies, to 6 month detailed technical analyses. I enjoyed the work most of the time but missed the direct measurable business impact I had enjoyed in my earlier assignments. After three years as a global Exploration Geologist, I was once again ready for a change.

In 2005, ConocoPhillips was increasing its campus recruiting and had hired a significant number of Early Career Geoscientists and Engineers. A new position was created, Technical Skills Manager, to ensure these staff received appropriate training and the well-rounded work experience required for successful careers in the Petroleum Industry. I applied for this position, and was selected.

I have now been Technical Skills Manager for ConocoPhillips longer than any other position I've held in the company. It is the best job I've ever had, and all of my previous positions have contributed to my success.

What's next? Who knows! What I can say is that my career as a Petroleum Geoscientist with a Major Integrated Oil Company has been a wonderful series of opportunities through Boom and Bust cycles. I could not have planned it all out in advance, but that does not mean that planning has not been critically important. As I conclude this summary, a few points stand out to me:

- Strong technical skills are critical to success, but alone they are not enough. You must apply your technical skills in a way that adds value to your company to be successful.
- Go where you are needed, and you can have the biggest impact, even if it may not be a location that was initially on your radar.
- You can't do it alone. University Faculty, Mentors, Supervisors, colleagues, friends and family have all been critical to my success along the way.
- There will be booms, busts, and other unexpected changes. Each one can provide opportunities if you look for them.
- Keep learning, and keep your skills current!

M. Charles Gilbert | 1961 Graduate

"HOW I BECAME A GEOLOGIST"

This story has several strands and so will take some time to develop. I was born in 1936 and grew up in Lawton, in southwestern Oklahoma, in the shadow of the Wichita Mountains. My family, including aunts and uncles and cousins, treasured the nearby Wichita Mountains Wildlife Refuge. We spent so much time picnicking, camping, and hiking in the Refuge that I thought we owned the place. Being able to climb around on the, to me, beautiful granite topography of the Wichitas was tremendously enjoyable and fulfilling.

Now, my youngest uncle who had been in the south Pacific during WWII had gone to OU after the war and gotten a degree in geology in 1947. He went to work for Stanolind in Kansas. I thus had become aware of geology as a discipline that one could study in college.

Then, when I got to Lawton High in 1952-1954, Miss Lily Stafford taught some of the individual science courses: chemistry, physics, and geology. She was a "terror" who did not tolerate lack of commitment to your class. She had taught most of my aunts and uncles, and so, had been around a long time. She was dedicated to her students getting immersed in science. When I had geology, she took us to meetings of the Oklahoma Academy of Science, particularly when they had field trips as part of the meetings. I remember clearly attending such a meeting when the fellow leading the field trip in the Arbuckles was C. W. Tomlinson, whom I later came to realize was one of the "grand men" of southern Oklahoma geology. What impressed me about him was his confident, but gracious, demeanor with a great ability to explain.

After high school, it was time to go on to college. What to major in? Geology seemed like it might be a good thing, not because a successful career might be ahead, but because it just might be fun to learn about the Earth. For financial reasons, my folks thought I could go to Cameron, then a junior college in Lawton, for the first year. No geology there but many of the basics could be taken and perhaps I should be able to press on at OU as a sophomore in 1955, which I did. The most memorable academic experience as an undergraduate at OU was the Geology Field Camp. In those days, the camp was 4 weeks long. Because of the large number of students, one session was held at the Criner Hills in Oklahoma, and 2 or 3 sessions were held in conjunction with Oklahoma State in Colorado. I went to the Canon City camp and, for the first time, finally saw "structure" and begin to really understand the 3-dimensional aspects of geology. In my 1958 graduating class there were over 150 BS degrees in Geology and Geological Engineering.

What next? I decided I wanted to learn more and applied for the graduate MS program at OU. I married that summer before graduate school and was glad to have a teaching assistantship. Professor George Huffman was in charge of the introductory physical and historical lab sections. I was assigned as a TA in historical and found teaching it one of the more challenging experiences I had had up till then. I saw how hard it was to do a good job explaining and mentoring beginning students. But the experience slowly began to make me think I might want to go on and perhaps even teach. I liked interacting with my TA colleagues. The first summer of graduate school, I was fortunate to have an internship with Magnolia Petroleum (i.e., Mobil) in Houston. In the second year, I hooked up with Hugh Hunter, a relatively new petrology professor from Canada who had received an NSF grant to study the gabbroic rocks of the Wichitas. He had attracted some other grad students interested in igneous rocks, and that first group of 3 (Bill Hiss, Burke Spencer, and myself) who worked on the outcrops around Roosevelt made a good team. I certainly learned a lot from all my fellow grad students, and began to feel like a real geologist. Upon completing the MS, I was fortunate enough to win an NSF Graduate Fellowship that permitted me to go for a PhD at UCLA.

The time at UCLA was exhilarating because that department was doing front rank research and had attracted really good grad students, many of whom became leaders in their respective fields as their careers unfolded. I was also fortunate, again, to become associated with a wonderful mentor, W. Gary Ernst, a new young faculty member who had been a fellow at the Geophysical Laboratory, Carnegie Institution of Washington. Gary had set up a new experimental lab at UCLA where mineral phases could be synthesized and studied. Thus, I worked in a lab where I was able to make and study a hornblende composition, one of the first end members of that large solid solution series. I also spent one summer as a field assistant to Gary mapping the Franciscan Formation in the California Coast Ranges. Finally, at the end of the PhD, I spent 6 months with Gary as a postdoctoral associate mapping in Japan (Shikoku) and in the Coast Ranges.

This story will not be like many of the ones OU grads have taken. However, it shows that there are lots of different outcomes, and different satisfying and productive careers, for those who love geology. After, UCLA days, I spent 3 years as a Fellow at the Geophysical Laboratory in full-time research, then 15 years as a professor at Virginia Tech, 7 on the faculty at Texas A & M, and 17 at OU on the faculty, coming in as Director of the School from 1990 through 1998. I have been blessed with very good colleagues, and very good mentors, throughout my life. The attachments that we alums naturally have to each other and to the School, because of our shared time at OU and the many friends made here, are the basis for our continuing support of the School.

As a professor of geology at 3 different universities, I have been able to work on a variety of interesting and stimulating research problems, with a variety of interesting and stimulating students and fellow faculty members. After UCLA, I mostly concentrated on lab studies, but had students at Virginia Tech who did field studies rather than lab-oriented studies. I took a sabbatical from Virginia Tech and came to the Oklahoma Geological Survey for a year (1977-78) to begin new work on the igneous geology of the Wichita Mountains. After I left Tech and went to TAMU, all my work focused on the Wichitas. To this day I find great satisfaction working on, and trying to explain, the Wichitas. My interests in that area have broadened so that all aspects of the geological history, from initiation of the Cambrian rift and emplacement of its rocks, to its submergence beneath a large interior basin, to its uplift as the easternmost Ancestral Rockies coincident with deformation of the Ouachitas, to its erosion and then covering by the Permian, and to its present-day re-exposure from on-going erosion as a limb of the Rio Grande Rift are exciting to me. Thus, all the processes involved: weathering, geochemistry, structure, magmatism, sedimentology, erosion, that were involved in that history, are now part of my studies and thinking. It is still a lot of fun. All the best for your having a good and satisfying life in geology and geophysics.

The Seven "C"s of Success

James A. Gibbs

A paper presented at the AAPG Convention in Long Beach, California April 1, 2007

(excerpts)

"*. . .* I'd like you to know how I view success. To me, it's not about money, although that's probably what initially motivates us to a greater or lesser degree, expecially when we are just starting out and wondering if we can stay in business long enough to make house and car payments and provide some security for our housemates. It's also the most common way we keep score of our progress. However, if one predicates success on money alone, the journey is likely to be a long and rough one. As the old saying goes, "He who marries for money earns every penny of it."

"For me, success is all about personal satisfaction, being totally absorbed in an idea or a project, and waking up truly excited to get back to work. It's having the freedom to decide what you want to do, when and where you want to do it, and with whom. It's the reward of spending long hours doing something you really enjoy and learning that you can do it as well or better than almost anyone else."

The Seven C'S are:

- Character
- Competence
- Commitment
- Concentration
- Creativity
- Concept
- Consistency

In Memory of Our Friends Who Have Passed

Norman Douglas Acree
Harold L. Ambler
Joseph H. Ambrister
Robert Gale Ash
Hayden C. Atchison
Michael Joe Birchum
Jack Elliott Black
Charles Frederick Brian
William L. Broadhurst
Michael J. Carney
Louie P. Chrisman
James Cockrell
Robert C. Cohen
James Marvin Corry
Edwin Burba Crowder
Henry L. Cullins, Jr.
Earl F. Cunnyngham
Guy Otis Danielson
Jaye F. Dyer
Glen A. Foltz
Harry Herbert Gilmore
Charles Campbell Green
Harry G. Hadler
Robert Wesley Hammond
Wilbur Duane Jones
J. B. Jordan
Guy W. Joyce
John J. Karpeck
Edwin P. Kerr
Robert A. Lucy
David R. Matuszak
Robert Weldon McComas
Mark N. McElroy
Edwin W. Merchant
Robert O. Mitchell
Anthony Thomas Moroney
Weston M. Oathout
William Edward Opalski
J. Durwood Pate
Lloyd Pippin
Thomas Ralph Pruitt
R. C. Slocum
C. W. Smith
Hoy N. Stone
Ralph L. Thompson
Virgil Dale Wiggins

Reported as of July, 2009

WANTED

Your OU Geology Field Camp Photos

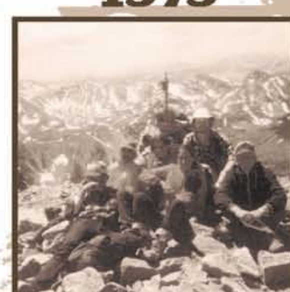
1952-1953





1977


1979


For a New Publication

Send to:
Neil Suneson (nsuneson@ou.edu)
Oklahoma Geological Survey
100 E. Boyd St., Rm. N-131
Norman, Oklahoma 73019

1952-53 photos, courtesy of W. J. "Jerry" Monk
1977 photos, courtesy of Jeanne (Carpenter) Callard
1979 photos, courtesy of Dale Murphy


View from high camp down to main camp
Cabins
Dining Hall
Cabins