

AAPG EXPLORER

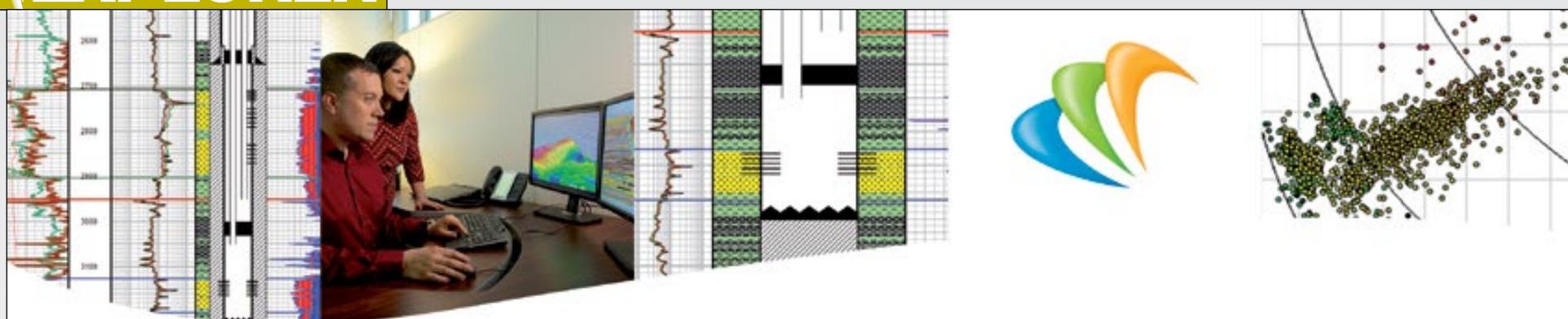
DECEMBER 2016

Soaring Heights

*AAPG honors its giants
and up-and-comers.*

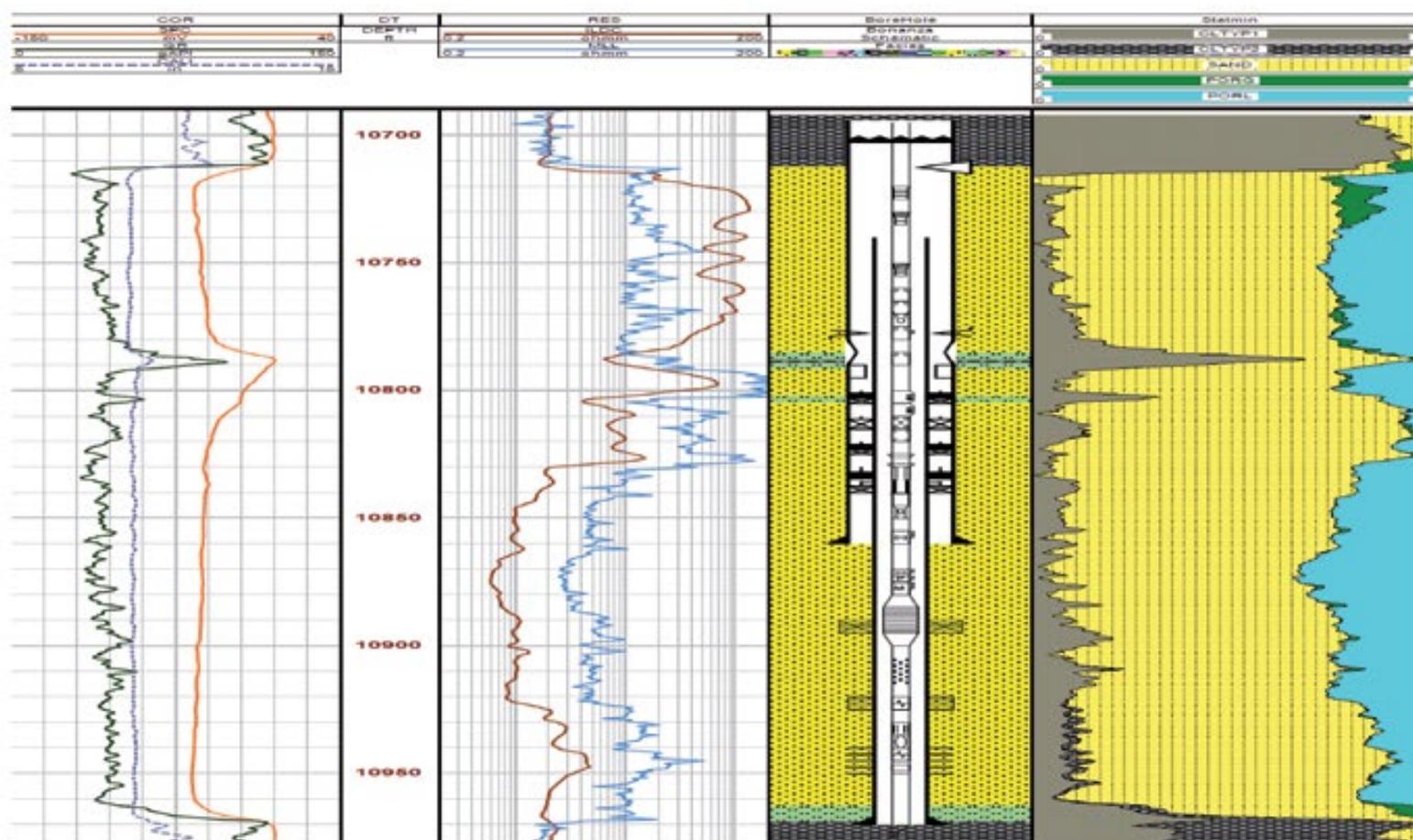
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PRESIDENT'S COLUMN

The Rewards of Giving Awards

BY PAUL BRITT

One of the most gratifying functions I have had the honor to perform as AAPG president is the interaction with those selected to receive awards from AAPG. Awardees are contacted by a personal call from the president to inform them of their nomination and selection to receive an award after a careful review by the Advisory Council and a vote by the Executive Committee.

In most cases, the nominees are unaware that they had been nominated to receive an award and the reaction upon hearing the news is always thankful and gracious. Hearing their response was in itself rewarding for me – a moment of joy I would not have experienced via email. In this age of instant communication and social media, I learned that it can be difficult to reach folks by telephone. It didn't dawn on me that reaching out with good news by a simple phone call might prove to be more challenging than expected. Some of the recipients were out of town, on vacation, on assignment at another location, even on an outcrop, and some were no longer at the company or recently retired but had not updated their contact information in the member directory.

So, I share with the Membership an important lesson: keep your contact information updated the old-fashioned way – it may just prove to be rewarding!

Nomination Process

I encourage all Members to take some time to consider nominating fellow Members for honors or awards. The process for nominating a Member for an AAPG award is simple. An award nomination kit is mailed out every year to every Member. It's up to the Membership to recognize someone they know and think is deserving of an award to complete a



AAPG Executive Director David Curtiss and the author at the 10th annual IPTC, held in Bangkok, Thailand this year.

nomination form and submit it.

It is a truly Member-driven process, and Members should not assume someone else is going to recognize and nominate a person for an award. So next year when the nomination kit comes to you in the mail, please use it to recommend someone you know and believe is deserving of an award for recognition.

A list of this year's award recipients is in this issue of the EXPLORER, so when you see one of the awardees at a local meeting or other get-together, please congratulate them on receiving the award. You may be pleasantly surprised by their appreciation, as I am sure they will be for the recognition.

Rewarding Event

The 10th International Petroleum Technology Conference (IPTC) was held in Bangkok, Thailand this year. This conference is a joint meeting held in

cooperation of four societies including AAPG, the Society of Exploration Geophysicists, the Society of Petroleum Engineers and the European Association of Geoscientists and Engineers. This year it was sponsored by PTT Exploration & Production, the Thailand national petroleum company.

Total attendance was 3,721, which was about the same as last year, and it proved to be a successful conference and continues to be an important revenue source for host societies.

The event was punctuated by the death of the Thailand's King Bhumibol Adulyadej the previous month. Bhumibol was revered by the people of Thailand and the country is observing an extended time of mourning, so conservative black attire was worn to honor his passing.

Princess Maha Chakri Sirindhorn, the Royal Princess of Thailand, presided over the opening ceremonies on Tuesday

morning. It was truly an honor to be in the presence of Thailand's royalty, and certainly a bit different from our typical opening ceremonies.

The conference drew attendees from nearly 60 different countries for cross-discipline talks that integrated geoscience and engineering for exploration, production, drilling and production topics. The theme of the conference was "Innovation and Efficiency Excellence for our Energy Future." The conference had an executive plenary session, four topical panel sessions, an IPTC Society Presidents Panel, four "Ask the Expert" sessions, and 53 technical sessions. Combined, they fulfilled the broad spectrum of topics, from exploration to facilities design, and from seismic to environmental, health and safety challenges.

A rewarding moment for me was to see AAPG Student Chapter members from several Indonesian universities fully engaged in the organization to help with the event. I extend my gratitude and thanks to these enthusiastic students for taking the time to assist Adrienne Pereira, AAPG's Asia Pacific Region project coordinator, in the AAPG booth.

The 11th IPTC is currently planned for early 2019 in Beijing, China. AAPG as an organization continues to provide leadership in geoscience for the oil and gas industry and we feel confident that many of the university students at this year's event will represent AAPG in 2019 as Young Professionals.

In closing, I want to also thank AAPG Member David Blanchard for his service to the IPTC as chairman and for making it a rewarding event. Well done.

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Courtesy of the XXXxx

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ON THE COVER:

The photograph from the south of Grand Teton in northwest Wyoming was taken by this year's Geosciences in the Media Award winner, Michael Collier. He took it for a book called "Creation of the Teton Landscape" written by David Love, Jack Reed, and Ken Pierce and published by the Grand Teton Natural History Association. See page 6 for more about Collier and the rest of this year's honorees.

Left: The Byron Station Nuclear Power Plant near Byron, Ill. is one of 100 licensed and operating nuclear power reactors in 35 states, with 11 new reactors under construction, which adds to the growing uncertainty about the future of nuclear waste disposal. See story on page 29.

'Pitchapalooza' Planned for ACE 2017

By KELSIE TAYLOR, EXPLORER News Editor

AAPG has a new event pairing high-potential projects that use new techniques and technologies with investors who are eager to support them.

Pitchapalooza will launch April 6 at the Annual Convention and Exhibition in Houston and will consist of a half-day of presentations.

Pitch Parameters

Susan Nash, AAPG's director of innovation and emerging science/technology, explained that individuals and companies can pitch and audience of potential investors.

Most of the pitches will be between 10-15 minutes in length and will seek enterprise-level funding, while mini pitches, or "Five for

Five" pitches, will be five minutes in length and will request a \$5,000 investment.

Nash explained that in order to join in, "they should own the rights to the property if it is a property, whether that be the leases, the minerals or a farmout. If it is funding for a technology, they should own the intellectual property."

Teams will make their pitch to an audience of representatives of venture capital, private equity, crowdfunding and personal investors.

Ideas of every shape and size can be pitched during the event. A sampling may include "exciting, environmentally friendly ways to optimize reservoirs, find new sources of energy and to solve environmental problems," said Nash.

"I think there will be a number of new approaches to the implementation of innovation, whether it be a technique, a technology, a product or a way to acquire and process new information," she added.

Providing the Tools

While the teams prepare for their presentations, AAPG will offer a variety of resources.

"We will provide a guide for the participants to follow so they cover all the key points and are consistent enough to be evaluated clearly," said Nash.

Toolkits will also be available, which will include valuable software for analytics.

Nash said she is working with software and information providers to gather packages for cloud-based solutions along with discounts for workstation-based packages. In addition, AAPG will offer a number of courses for petroleum economics and short courses.

Nash said the event will be valuable to the participants and investors alike.

"I think that the event can be absolutely transformative for individuals and companies, especially at this point in time when there are many very talented and experienced individuals who are free agents and can come together to tackle reservoir and environment problems, with great returns on investment and value to society," she said.

Nash developed the idea for Pitchapalooza after organizing workshops and courses like "Revitalizing Reservoirs" and "Making Money with Mature Fields" and others that involved interdisciplinary teams.

"I had the opportunity to speak to geoscientists, engineers, finance experts and landmen, and I could see that there were many opportunities, but people need a leg up – not just *capital*, but also *hope* in the form of a facilitating entity that will help create productive teams. It translates to career opportunities as well as potentially company-making ventures," she said.

"We're in a time of dramatic change and Pitchapalooza is envisioned as a change agent," Nash added. "We hope to have this expand so that we'll have four or five events a year – associated with conferences and conventions, or as stand-alones."

To learn more about the event, contact Nash at snash@aapg.org.

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Email Changes Coming

Everyone involved in AAPG receives emails throughout the year from the Association. They serve as an important and convenient way to share information about everything happening at AAPG.

Last month, AAPG announced a few changes will be made to these emails and the procedure by which we send them. This is due to new international laws, which mandate that AAPG can only send communication to those who explicitly indicate they would like to receive them.

The Association is creating email contact lists in full compliance with these laws. To that end, AAPG staff are asking everyone to communicate with us about whether you want to continue to receive emails by visiting and logging in to www.aapg.org.

When logged in, click 'My Profile' and then 'Contact Preferences.' Then enter the types of emails that you would like to receive.

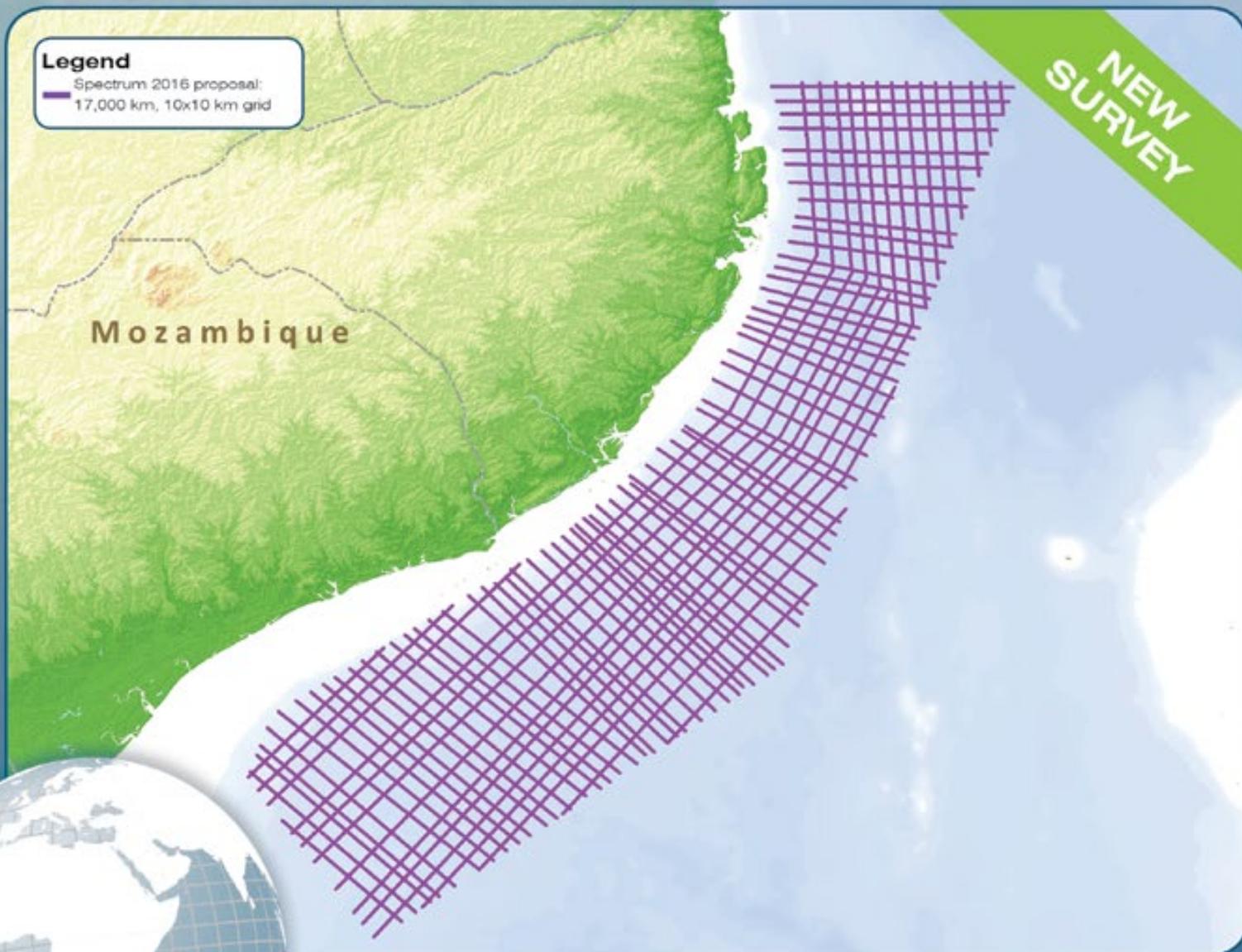
When complete, you will receive two e-mails: one will list the details of your changed preferences and the other will include a link to follow that will confirm your e-mail address.

AAPG recently sent a survey that will further help the Association by sharing the types of communication that everyone would like to see in the future. It would be greatly appreciated if you could take a few minutes to fill out the survey at <http://aapg.to/survey201611>.

multi-client seismic
MOZAMBIQUE

Offshore Mozambique

New Broadband Multi-Client Seismic Survey



Spectrum has been selected to undertake a comprehensive long-offset Broadband 2D Multi-Client seismic survey offshore Mozambique. The survey will comprise a variable grid totalling in excess of 16,000 km.

This new seismic data will image the subsurface potential in open areas of the southern Rovuma Basin and the western flanks of the Kerimbab Graben, west of the Davie Fracture Zone, revealing the prospectivity in this region for the first time. Potential targets include Cretaceous and Tertiary turbidites and buried canyon plays. The survey will also aim to image the syn-rift structures and Late Cretaceous pro-delta stacked turbidite sequences in the north-east Zambezi Depression.

New 2D data will play a key role in refining our understanding of the hydrocarbon potential of the area and accelerate exploration activity in what is believed to be an oil-dominated region offshore Mozambique.

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AVARY



COOK



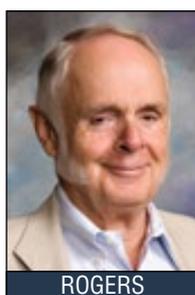
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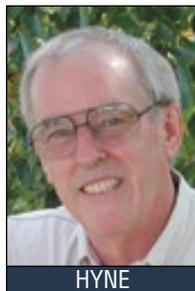
NEHER



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WICKSTROM



HYNE

Announcing the Honored Best of AAPG

By BRIAN ERVIN, EXPLORER Managing Editor

Lawrence "Larry" Meckel is the recipient of the Association's highest honor, the AAPG Sidney Powers Memorial Award.

Meckel is an Honorary Member and celebrated for his extensive subsurface experience and his innovations in integrated applied research. He is a past winner of AAPG's Grover E. Murray Distinguished Educator Award for his numerous contributions to geological education.

He has his own exploration consulting company based in Denver, and is also an adjunct professor at the Colorado School of Mines, teaching courses on unconventional petroleum systems.

He is also well known to AAPG Members for his many lectures through AAPG and other societies.

AAPG Honorary Member **Edward Dolly** joins him at the top of the awardees list as this year's recipient of the Michel T. Halbouty Outstanding Leadership Award.

Dolly already has more than half a dozen AAPG and House of Delegates awards to his credit, including the A.I. Levorsen Award, a Distinguished Service Award and a few Certificates of Merit. In recent years, he's been a driving force as a leader and member of AAPG's 100th Anniversary Committee and in the creation of the GeoLegend videos that were so wildly popular when they debuted at the Annual Convention and Exhibition (ACE) in Denver last year.

Meckel and Dolly will be recognized, along with the rest of the AAPG award winners, at the opening session of the 2017 100th Anniversary ACE in Houston, set for April 2-5.

AAPG awards, approved by the Executive Committee, are presented annually to recognize individuals for service to the profession, the science, the Association and the public.

Biographies and citations of all award winners will be included in a future AAPG BULLETIN.

Joining Meckel and Dolly as this year's AAPG awardees are:

Honorary Member Award

Presented to Members who have distinguished themselves by their accomplishments and through their

service to the profession of petroleum geology and to AAPG.

□ **Katharine "Lee" Avary**, independent, Morgantown, W. Va.

□ **David Cook**, ExxonMobil (retired), Essex, U.K.

□ **Steven Goolsby**, Goolsby Brothers and Associates, Lakewood, Colo.

□ **Leslie Magoon**, Stanford University, Cupertino, Calif.

□ **Walter "Rusty" Riese**, retired, adjunct professor and lecturer, Houston.

□ **James "Jim" Rogers**, National Geological Services, Aurora, Colo.

Norman H. Foster Outstanding Explorer Award

Presented to Members in recognition of distinguished and outstanding achievement in exploration for petroleum or mineral resources, with an intended emphasis on recent discovery.

□ **Terry Mather**, Thomasson Partner Associates, Castle Rock, Colo., honored for his contribution to the Boise Basin discovery and his persistent effort to discover the first production in the state of Idaho.

Robert R. Berg Outstanding Research Award

Presented to honor a singular achievement in petroleum geoscience research.

□ **Julie LeFever**, U.S. Geological Survey, Grand Forks, N.D., honored for her pioneering role and expertise in petroleum geochemistry.

Distinguished Service Award

Presented to those who have distinguished themselves in singular and beneficial long-term service to AAPG.

This year there are nine recipients of

the honor:

□ **Fowzia Abdullah**, Kuwait University, Safat, Kuwait.

□ **Anwar Al-Beajji**, Saudi Aramco, Dhahran, Saudi Arabia.

□ **Sylvia Anjos**, Petrobras, Rio de Janeiro, Brazil.

□ **Mary Broussard**, Freeport-McMoRan Oil and Gas, Lafayette, La.

□ **Richard "Rick" Fritz**, Council Oak Resources, Tulsa.

□ **Creties Jenkins**, Rose and Associates, Santa Barbara, Calif.

□ **Kurt Neher**, California Resources Corporation, Bakersfield, Calif.

□ **Robert "Bobby" Ryan**, Chevron, Houston.

□ **Lawrence "Larry" Wickstrom**, Wickstrom Geoscience, Worthington, Ohio.

[Continued on next page](#)

Meckel, Dolly Recognized for Excellence in Science, Leadership

Renowned explorationist, consultant and professor Larry Meckel is the 70th winner of the AAPG Sidney Powers Memorial Award, which is given annually in recognition of distinguished and outstanding contributions to, or achievements in, petroleum geology.

The award's namesake was a founding Member and 14th president of AAPG. He died in 1932 at the age of 42. He is revered as an icon of petroleum geology, both for his scientific excellence and for his character, and the award is given each year to the AAPG Member who best represents the qualities exemplified by Powers.

Meckel has been one of the leaders in discovery thinking throughout his more than 50-year career through his innovative integration of rock data with seismic and engineering data, which he has used to develop new approaches in discovery thinking through prospect generation and short courses.

He has been instrumental in the discovery of more than a dozen oil and gas fields throughout the United States, Canada and Mexico, including the giant Elmworth gas field in Alberta.

Meckel has also dedicated himself to the development of explorationists throughout his career and, owing to his personal success, has been in high demand as an instructor. He



LAWRENCE



DOLLY

has instructed 15 different company training courses, 12 different modern and ancient field seminars and given numerous lectures through AAPG and other societies, and was the recipient of the AAPG Distinguished Educator Award in 2011.

For the past decade, Meckel has been an adjunct professor for the Department of Geology and Geological Engineering at the Colorado School of Mines, teaching and advising students at the graduate level.

He began his career after earning a doctorate in geology at John Hopkins University, taking his first job at Shell Development Company, where he participated in industry research that helped drive the revolution in sedimentary geology. After nearly a decade working for Shell, he went on to become a partner in a consulting firm before eventually striking out on his own,

creating L.D. Meckel and Company.

Edward Dolly is the 11th recipient of the Michel T. Halbouty Outstanding Leadership Award, given in recognition of outstanding and exceptional leadership in the petroleum geosciences.

Dolly is regarded by colleagues and fellow AAPG Members as "the epitome of the professional geologist" for his vision and diligence as past chair of the AAPG 100th Anniversary Committee, his impressive accomplishments as a leader within the House of Delegates, both as chair and as representative of the Rocky Mountain Association of Geologists, as well as for his past service on the Executive Committee the Advisory Council, and numerous other positions of leadership within AAPG.

An exhaustive list of all of Dolly's official and unofficial leadership roles within the Association would exceed the scope of this piece, but in each instance, he distinguished himself as someone with extraordinary patience, diligence, passion and vision who has brought transformational focus, structure and direction to whatever committee or project he has led.

Interviews with both Meckel and Dolly will be published in future issues of the EXPLORER. [E](#)



JOHNSON



GARDNER



QIU



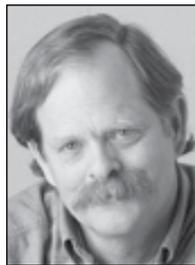
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SHANLEY



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SCHOLLE



SCHIEBER



RAINE



ENGLISH

Continued from previous page

Grover E. Murray Distinguished Educator Award

Presented for distinguished and outstanding contributions to geological education, both at the university level and toward education of the general public.

□ Norman "Norm" Hyne, University of Tulsa, Tulsa.

□ Cari Johnson, University of Utah, Salt Lake City, Utah.

Harrison Schmitt Award

Presented to recognize individuals who, for a variety of reasons, do not qualify for other Association honors or awards.

□ Julia Gardner, U.S. Geological Survey, posthumously honored for her pioneering work as the one of the first oil and gas biostratigraphers, among a host of other accomplishments and distinctions.

□ Zhongjian Qiu, CNPC, Beijing, China, honored for his outstanding leadership in petroleum geoscience and sustained contribution to the Chinese petroleum industry for over 60 years.

Public Service Award

Presented to recognize contributions of AAPG Members to public affairs – and intended to encourage such activities.

□ W. "Lynn" Watney, Kansas Geological Society, Lawrence, Kan., honored for his efforts in educating the public and policymakers on the role of evaporite karst in the Hutchinson, Kan. gas explosions.

□ Friends of Dinosaur Ridge (Volunteer Board Member Norb Cygan), Morrison, Colo., honored for the organization's ongoing contributions to the education of the general public regarding the paleontologic, geologic and historic resources on Dinosaur Ridge.

Pioneer Award

Presented to long-standing Members who have contributed to the Association and who have made meaningful contributions to the science of geology.

□ John Oty, independent, Green Valley, Ariz., honored for his contributions and discoveries at the Brandon Field in Colorado, among other exploration projects throughout the Rocky Mountains.

Geosciences in the Media Award

Presented for notable journalistic achievement in any medium, which contributes to public understanding of geology, energy resources or the technology of oil and gas exploration.

□ Michael Collier, photographer and author, Flagstaff, Ariz., honored for his



life's work as an ambassador for the geosciences through his photography, books, exhibits and other projects.

Young Professional Exemplary Service Award

Presented to Members who have promoted growth, awareness and expanded opportunities within the organization for Young Professionals.

□ Aisha Al-Bulushi, Petroleum Development Oman, Muscat, Oman, honored for ensuring students and YPs in the Middle East have opportunities to enrich their geoscience careers.

□ Catherine "Cat" Campbell, Robert L. Bayless, Producer, Denver, honored for her tireless support and advocacy for YPs in industry and AAPG.

□ Nick Lagrilliere, Maersk Oil, Houston, honored for his unyielding support and accomplishments in expanding the scope of YP involvement in the Association.

□ Ryan Lemiski, Calgary, Canada, honored for promoting growth and expansion of YP involvement in the Association.

Wallace E. Pratt Memorial Award

Presented to honor and reward the author(s) of the best AAPG BULLETIN article published each calendar year.

□ Keith Shanley and Robert "Bob" Cluff, for "The evolution of pore-scale fluid-saturation in low-permeability sandstone reservoirs" (AAPG Bulletin, October 2015).

Robert H. Dott Sr. Memorial Award

Presented to honor and reward

the author/editor of the best special publication dealing with geology published by the Association.

□ Dana Ulmer-Scholle, Peter Scholle, Juergen Schieber and Robert Raine, for AAPG Memoir 109: A Color Guide to the Petrography of Sandstones, Siltstones, Shales and Associated Rocks. Dana Ulmer-Scholle and Peter Scholle own Scholle Petrographic, based out of Magdalena, N.M.

J.C. "Cam" Sproule Memorial Award

Presented to recognize and reward younger authors of papers applicable to petroleum geology.

□ Joseph English and Luke Ferreira, for "Geologic evolution of the Iraqi Zagros, and its influence on the distribution of hydrocarbons in the Kurdistan Region" (AAPG BULLETIN, February 2015).

John W. Shelton Search and Discovery Award

Presented in recognition of the best contribution to the "Search and Discovery" website in the past year.

□ Mike Blum, Kristy Milliken, John Snedden and William Galloway, for "Record of Cretaceous through Paleogene Gulf of Mexico Drainage Integration from Detrital Zircons" (Presented at the 2015 ACE in Denver).

SEG/AAPG Best Paper In Interpretation Award

Presented in recognition of the best contribution to the new SEG/AAPG journal, "Interpretation."

□ Roderick Perez Altamar and Kurt Marfurt, University of Oklahoma, Norman, Okla., for "Identification of brittle/ductile areas in unconventional reservoirs using seismic and microseismic data: Application to the Barnett Shale" (INTERPRETATION, November 2015).

George C. Matson Award

Presented to honor and reward the best oral presentation at the 2016 AAPG Annual Convention and Exhibition in Calgary.

□ Martin J. Kennedy, Stefan Loehr and Natalie Debenham, Macquarie University, Sydney, Australia, for "Seeing is Believing; High Resolution Electron Imaging and Mineral Mapping Shows Trace Minerals can Control Reservoir Properties."

Jules Braunstein Memorial Award

Presented to honor and reward the best poster presentation at the 2016 AAPG Annual Convention and Exhibition in Calgary.

□ Jenna M. DiMarzio, Svetoslav V. Georgiev, Holly Stein and Judith Hannah, Colorado State University, Fort Collins, Colo. for "Effect of Precipitation of Asphaltenes on Re-Os Isotopic Ratios."

Gabriel Dengo Memorial Award

Presented to honor and reward the best oral presentation at the 2016 AAPG International Conference and Exhibition in Cancun, Mexico.

□ Thomas Murphy, LT Environmental Inc., Arvada, Colo., for "Groundwater Environmental Liability Management Using Baseline Sampling Programs."

Ziad Beydoun Memorial Award

Presented to honor and reward the best poster presentation at the 2016 AAPG International Conference and Exhibition in Cancun, Mexico.

□ Daniel Emiliano Bolaños-Rodríguez, Manuel Cruz-Castillo and Adriana Acosta-Angeles, for "Conceptual Geological Model About Hydrocarbon Flow Through Fractures in Siliciclastic Sequences of the Chicontepec Formation."

All of the authors are with the Mexican Institute of Petroleum.



FERREIRA



BLUM



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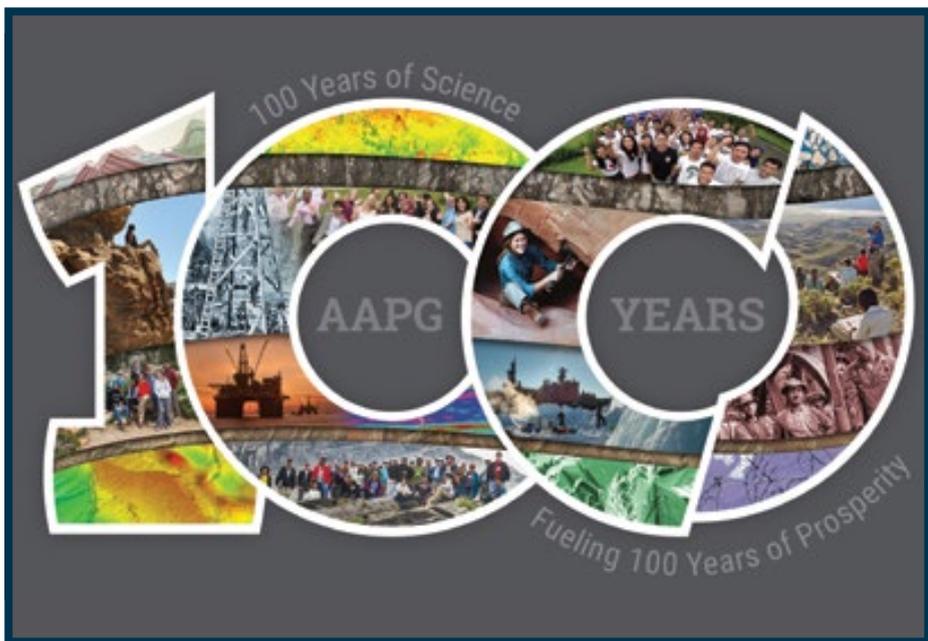
GALLOWAY



PEREZ ALTAMAR



MARFURT



A Century of Science Fueling Prosperity

By **DAVE RENSINK**, ACE 2017 General Chair

The theme for the 2017 Annual Convention and Exhibition is “100 Years of Science Fueling 100 Years of Prosperity.” It is our intention to honor the past and look to the future.

The planning for next year’s celebration of AAPG’s 100th anniversary at ACE in Houston began more than 10 years ago by the 100th Anniversary Committee. The planning began in an environment of \$90

to \$100/barrel, and the execution will be in our current \$40 to \$50/barrel reality.

What to Expect at ACE 2017

Nonetheless, the committee will be showcasing two Discovery Thinking sessions, video interviews with prominent petroleum geoscientists, poster and digital displays of significant outcrops, and compilations of significant papers and past field trips.

Other committees are also planning significant programs for 2017. The Professional Women in Earth Sciences Committee will be honoring 100 years of women in petroleum geoscience with a program on Saturday and a historical timeline of the first 100 female Members of AAPG

on display in the convention hall near the technical sessions.



RENSINK

The Energy Minerals Division and the Division of Environmental Geosciences are joining to present a symposium on Tuesday afternoon entitled “The Next 100 Years of Global Energy

Use: Resources, Impacts and Economics.”

We plan to have a 100th anniversary gala celebration on Monday evening. This will entail a program highlighting our history, a talk by a noted authority and a dance band composed, at least in part, by geologists.

Our noted authority, Daniel Yergin, is about as noted as you can get in this business. Yergin is a leading expert on energy, geopolitics and the global economy, bestselling author, and a winner of the Pulitzer Prize. He is on the contact list of every energy corporation CEO and world leader with an interest in the energy business.

In addition, we will also provide a location for those of you who wish to talk over coffee away from the dance band.

We had more than 2,300 abstracts submitted, so as always, the technical program will be the premier event. That will never change.

Interaction and Synthesis

AAPG was started by a group of geologists in the early part of the 20th century who wanted to foster friendship and the exchange of data and ideas about petroleum geology.

I think a 1987 quote by Stephen Jay Gould from “An Urchin in the Storm: Essays about Books and Ideas” sums up what we are all about. “No Geologist worth anything is permanently bound to a desk or laboratory, but the charming notion that true science can only be based on unbiased observation of nature in the raw is mythology. Creative work, in geology and anywhere else, is interaction and synthesis: half-baked ideas from a bar room, rocks in the field, chains of thought from lonely walks, numbers squeezed from rocks in a laboratory, numbers from a calculator riveted to a desk, fancy equipment usually malfunctioning on expensive ships, cheap equipment in the human cranium, arguments before a road cut.”

We hope you are making plans to join us in Houston the first week in April 2017. [E](#)

Submit Your Abstracts

Be a part of history by presenting at the premier integrated geosciences event in 2017 at ICE in London incorporating AAPG’s 100th Anniversary. Your expert contribution and practical guidance will help promote and advance the exploration and production of global energy resources. Industry professionals, academics and students are invited to submit abstracts that relate to any of the ICE 2017 Themes listed below:

Deadline 31 January 2017

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Schlumberger, Statoil Look Ahead to 'LALA' Land

By DAVID BROWN, EXPLORER Correspondent

In downhole logging and resistivity measurement, we're getting close to LALA land.

The latest advance in technology comes from researchers at Schlumberger and Statoil, who have developed and deployed a new electromagnetic look-ahead tool, or EMLA.

Still in the prototype stage, EMLA is a modular device that contains a low-frequency electromagnetic transmitter 1.8 meters (about 6 feet) behind the bit in a rotary steerable drilling tool.

The transmitter creates currents at multiple frequencies both around and in front of the bit. Then two or three receivers spaced along the drill string record the induced magnetic field.

Through inversion of the signals, the formation structure ahead of the bit can be interpreted by differentiating sensitivity around the tool from effects in front of the bit.

And, like magic, drillers can get a glimpse of the geology they're drilling into.

"The EMLA tool provides a step change with regard to precision in detecting changes in resistivity properties ahead of the bit in vertical and low-angle wells. The ability to react to resistivity contrasts ahead of the bit has a direct impact on how wells are drilled," the researchers wrote in an article published in the October issue of *Petrophysics*.

Toward Look-around/ Look-ahead Capability

Whether or not it really is a step



TORRES-VERDIN

"The main reason for look-around and look-ahead capabilities while drilling is for effective well navigation..."

change, the EMLA tool does take another step toward a destination loggers have been targeting for a long time: downhole devices that allow drillers to see what they are drilling into and what they are drilling through, in real time, using look-around/look-ahead capability.

That's LALA.

"The main reason for look-around and look-ahead capabilities while drilling is for effective well navigation – well geosteering – through reservoir pay and to avert and avoid drilling risk," such as changes because of faults, said Carlos Torres-Verdin.

Torres-Verdin is a professor in the Petroleum and Geosystems Engineering Department at the University of Texas at Austin and a 2015 Distinguished Member of the Society of Petroleum Engineers.

"In the near future, with the technology already there, simultaneous look around and look ahead while drilling will be available," researchers wrote in a paper presented at the Society of Petrophysicists and Well Log Analysts annual symposium in June.

"Interpretation of measurements in 2-D and 3-D environments is the main

challenge to overcome to make LALA happen," they noted.

One well-established benefit of look-ahead capability comes from reducing idle rig time and other nonproductive time by enabling drillers to make decisions and adjustments without halting or delaying drilling operations.

Expensive delays can occur when drilling has to be stopped for computation time using downhole data.

Earlier Steps Toward LALA

Some earlier versions of look ahead utilized seismic/acoustic tools, including seismic-while-drilling (SWD). SWD at first used energy from roller-cone bits as a seismic source, with geophones picking up the seismic waves. As bits changed, the industry switched to surface seismic sources.

Schlumberger developed a Seismic-Guided Drilling (SGD) service, using surface seismic and logging-while-drilling data to identify geological and geomechanical features.

"By predicting hazards and pore

pressure ahead of the bit and establishing a 3-D velocity model that quantifies uncertainties and discrepancies between multiple models," the SGD service improved both drilling safety and well costs, the company said.

Even when LALA doesn't offer "real" – instantaneous – real-time capability, the goal is to allow the drilling team to make downhole adjustments without interrupting drilling operations.

Statoil described other benefits from use of the EMLA tool, one involving a subsalt-play well in the Gulf of Mexico. A main objective was to detect bottom salt before drilling through it.

For that well, three EMLA receivers were used to maximize look-ahead distance, deployed at 10.9 meters, 21.5 meters and 35.3 meters from the transmitter. Although seismic uncertainty was high in the salt, the salt formations were insulating and a nearly perfect environment for the EMLA device, the researchers noted.

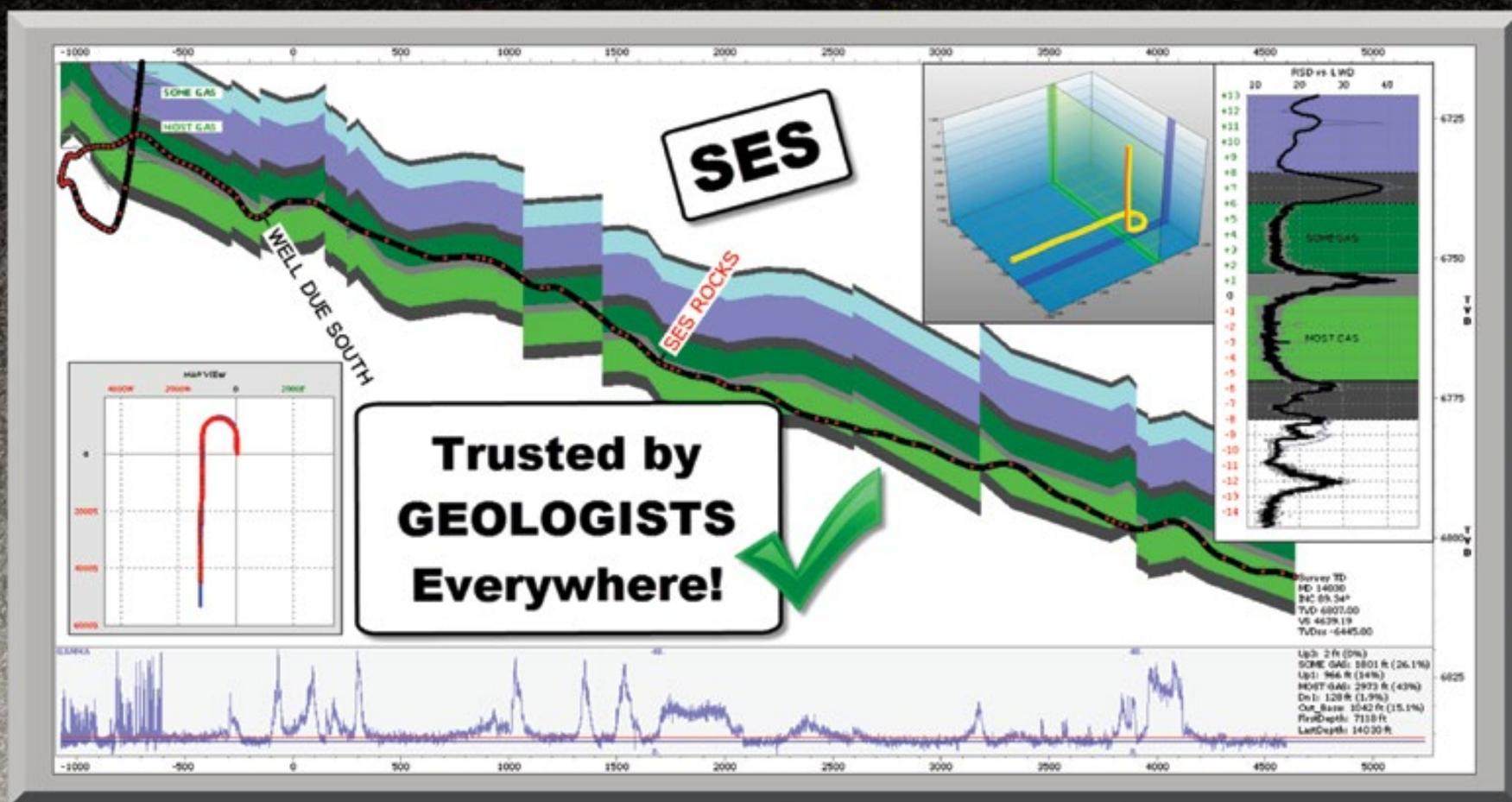
"The bottom salt was detected 30 meters ahead of bit, which gave the drillers an early warning of the salt exit and potential drilling challenges," the researchers wrote.

In another application, in the North Sea Staffjord field, the objective was "to stop and set casing close to the reservoir in order to allow drilling with a low mud weight in the depleted reservoir section to prevent fracturing of the formation," the researchers said.

Statoil planned to detect and stop 3

See EMLA, page 14

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A Legacy Etched in Rock

By ANGELA EVANS, EXPLORER Correspondent

Malcolm Gooding has spent hundreds of hours in the field. He has worked with microbiologists to test the concentration of E. coli in local water systems. He has done dye tracing with hydrologists in a karst area to see how and where the water traveled. He has worked with geologists to gather water samples to prepare for various analyses.

And, he recently presented a poster, “Most Effective Methods in Identifying, Etching, and Dissolving Limestone,” at the AAPG Eastern Section Meeting.

Malcolm Gooding is 13 years old. The 8th-grader from Lexington, Ky, participates in the local 4H program where he has been the Overall Grand Champion in Geology at the Kentucky State Fair for four years straight. He’s a life-long Boy Scout who is only one level from becoming an Eagle Scout. He also plays viola in the Morton Middle School band.

At such a young age, his resume is already more impressive than most adults’. But when asked about his hobbies outside of all these activities, the answer couldn’t be more normal.

“Does sleep count?” he asked. “If so, then sleep, television and food. Oh, and Pokemon.”

It Runs in the Family

Malcolm comes from a family of scientists – overachievers, some might say. His grandfather, Patrick Gooding, an AAPG Member and career geologist who immigrated to the United States from the Port of Trinidad, Spain on a track scholarship in 1971, has given him the exposure to opportunities that most kids don’t have.

“I’ve been with the Kentucky Geological Survey research department at the University of Kentucky for 39 years,” said Patrick. “My grandson, Malcolm, has been on several Geological Society of Kentucky field trips and spent many hours in the field with me and at my office since he was very young.”

He couples his role as grandfather with his role as educator, providing his grandchildren with learning experiences outside the classroom.

“I’ll wake them up at 1:30 a.m. while on vacation in Florida to see turtles laying eggs or to see a space shuttle take off. They know that when the car stops, it is time to get out and examine the rocks and collect samples even though they



Gooding imparts his love of science and geology to his grandchildren through trips to places like Big Bend National Park in southwest Texas.

are half asleep,” he said. “I seize every opportunity to take all my grandchildren to visit our wonderful National Parks. They participate in hikes, ranger programs, museum visits, park activities and the Junior Ranger Program.”

Malcolm has been to 35 national parks over the years with his grandfather. A couple of his favorites are Mammoth Caves and Carlsbad Caverns.

“I like caves. I like the dark, gloomy feel – all the high edges, the cave cliffs, that there is little vegetation.”

His first cave experience was at Climax Caves in Kentucky with his Boy Scout troop. Most of his fellow Scouts approached the caves with trepidation. Not Malcolm, though.

“As long as I can remember, I have been going on expeditions. So, I’m definitely not scared of nature,” he said.

For Patrick, these adventures with his grandchildren aren’t just learning opportunities; they have deeper meaning.

“We go to see volcanoes and sand dunes, or the Grand Canyon, which I have been to many times and studied while I was in college,” he said. “But to stand at the rim of the Grand Canyon and show my grandchildren for the first time – experiencing the beauty of it – it’s always exciting for me and my wife.”

Never Too Young

Recently, Patrick found a project for his grandson closer to home. Patrick has been a Member of AAPG for 34 years and is currently serving his seventh year as a member of the House of Delegates. Lexington was the site for the 2016 Eastern Section Meeting, which gave

Gooding the opportunity to mentor his grandson for a project.

“When he’s at my office, he’s always looking for new projects. We started talking about how geologists always use one particular acid when working with limestone. He wondered if there were better alternatives,” he said.

Malcolm’s study, titled “Most Effective Methods in Identifying, Etching, and Dissolving Limestone,” required at least 150 hours of collecting, slabbing, weighing, mixing acids, testing, photographing, preparing graphs, analyzing the data and reaching conclusions.

“I ended up doing 164 samples, looking at the effects of different acids on different types of limestones from all different ages. The results were pretty cool,” said Malcolm.

He was accepted as a presenter at the AAPG Eastern Section Meeting – perhaps one of the youngest presenters ever – where he explained and defended his work to those in attendance.

“I would send people over to test him and his knowledge. It’s good practice for him and he performed very well,” said Gooding. “But his results are also very beneficial for the geological community.”

Malcolm knows that the work he does is significant and that understanding how the environment works is important for all of us.

“Like when I worked on the E. coli study, I knew it was important for people to know if their water was safe. If they don’t know these things, they could end up harming themselves or others by going places that are unsafe,” he said.

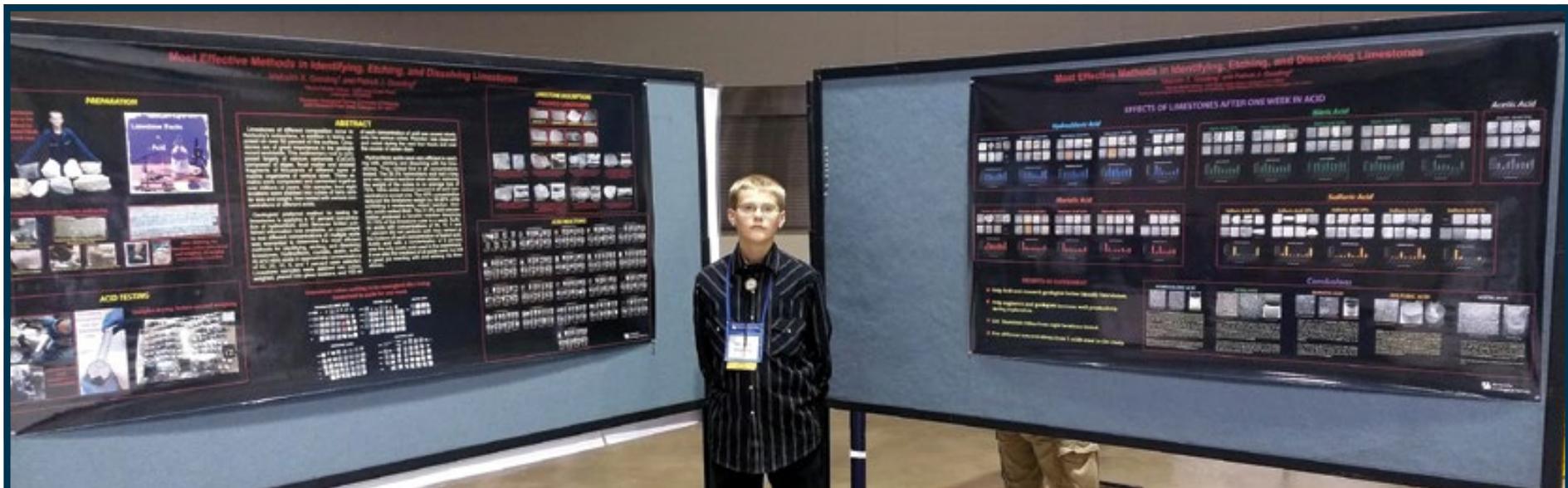
Malcolm visits his grandfather every weekend, where they spend time outdoors exploring, studying and always looking for their next project.

That doesn’t mean there isn’t a little down time.

“When I’m with my grandfather, I don’t get to play video games. He loves science and loves going outside. But we still spend a lot of time on the couch watching television together,” he said.

Now, Malcolm’s sister has become interested in competing in the 4H geology section like her brother. Patrick doesn’t allow his grandchildren to just go out and buy the rocks and gems needed to become a grand champion, like some competitors do. Instead, he takes them directly to the source to collect them.

“So, it looks like I have to start all over again with her,” he laughed, “and I couldn’t be happier.”



Malcolm Gooding, 13, presented “Most Effective Methods in Identifying, Etching, and Dissolving Limestone” at the AAPG Eastern Section Meeting recently.

Downturn Drives Downhole Improvements

By LOUISE S. DURHAM, EXPLORER Correspondent

Technological innovations are the life-blood that keeps the oil and gas industry not just alive, but growing, albeit sometimes at a snail's pace. The current improved, yet still-struggling industry is testament to what technology can accomplish.

Significantly, the downturn appears to have motivated well service companies and others to work even more diligently than usual to introduce new and/or improved applications for efficient drilling and production, with an eye toward tweaking cost both for themselves and the operators who have been slammed in large part during the past couple of years.

Baker Hughes

Taking a quick look at some of the latest activity, it's fitting to begin with this oilfield service provider, which has roots dating back more than 100 years prior to the 1987 merger of Baker Tools and Hughes Tool companies. Today, it's widely reported to be on the brink of combining with GE's Oil and Gas division to create a new industry giant.

The company announced earlier this year that its Integrity eXplorer Wireline Cement Evaluation Service received an Offshore Technology Conference (OTC) Spotlight on New Technology award, which is presented to selected OTC exhibitors for the most innovative hardware and software technologies for offshore exploration and production. Wellbore integrity and zonal isolation are paramount for safe, productive oil and gas wells, according to Mariano Garguilo, vice president of wireline services



Sercel's Geowave II was the industry's first digital multi-level array specifically designed for high-temperature, high-pressure wells.

at Baker Hughes. He noted, however, that existing acoustic-based cement evaluation techniques can't always turn out the reliable information crucial to operators in the current complex environments.

"The Integrity eXplorer Service, which uses proprietary electromagnetic-acoustic transducer technology, sets a new standard for cement bond evaluation and enables operators to obtain comprehensive wellbore integrity answers," he said.

Schlumberger

This oilfield services behemoth apparently doesn't miss a beat when it

comes to addressing downhole needs and challenges. In May of this year, the company launched the industry's highest-pull wireline conveyance system. Dubbed MaxPull, this high-pull system expands wireline capabilities to any well trajectory while reducing costs and risks, according to Schlumberger. The company noted that deep and highly deviated wells that present safety and logistics concerns or else weren't previously wireline accessible are poised to benefit significantly from the use of an integrated wireline conveyance system such as MaxPull.

"Drillers can expect drill-pipe-free wireline operations in any environment

with vertical well efficiency and minimum sticking risk," said Hinda Gharbi, president of Wireline, Schlumberger.

Sperry Drilling

This Halliburton business recently announced the release of the 9.5-inch Azimuthal Lithodensity (ALD) service to provide real-time density measurements and images in boreholes ranging up to 17.5 inches. The downhole density measurements, including high quality borehole image logs, help optimize wellbore placement through geosteering and reduce geological uncertainties, according to Sperry. The measurements are delivered via logging-while-drilling, eliminating pricey wireline conveyance runs, and they capture data immediately after drilling when the borehole is still a relatively pristine environment. The info provided by the 9.5 inch ALD service has myriad applications to help determine porosity of a formation, rock strength, pore pressure and borehole geometry.

According to Sperry Drilling Vice President Corey Walker, ALD addresses an important market need and is currently the only commercially available logging while drilling density service designed for large diameter boreholes.

"In areas like the Gulf of Mexico and other regions where large boreholes are common, we are well positioned to meet increasing demand," Walker said.

See **Hostile Conditions**, page 14

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Earthquakes in the Heartland

Shake, Rattle and Responsibility

By **BARRY FRIEDMAN**, EXPLORER Correspondent

As earthquakes go, it was, said Tandsi S. Bidgoli, “Enough to cause all the various stakeholders to sit up and take notice.”

Those stakeholders are regulatory agencies, the oil and gas industry, and the public.

A 5.8-magnitude earthquake without foreshocks will do that.



BIDGOLI

Bidgoli is an AAPG Student/Young Professional member, structural geologist and thermochronologist with the Energy Research section of the Kansas Geological Survey.

About the quake near Pawnee, Okla. the morning of Sept. 3, she said, “Although events of this size are fairly common near plate margins, like in California, they are not a normal occurrence in the mid-continent.”

But it’s getting that way.

As the area experiences more of these quakes and the two states of Kansas and Oklahoma now face the same threat of destructive earthquakes as do Californians, Bidgoli said there has to be a change in the mindset as how they prepare for them.

Cause for Concern, and for New Models

Specifically, she said, because the Sept. 3 earthquake came without warning.

In other large quakes, she explained, there had been smaller foreshocks leading up to the big one. Bidgoli’s worry comes because the recent 5.8 quake was the foreshock.

And if the 5.8 magnitude quake was the foreshock, what else might be coming?

“Our group at the Kansas Geological Survey is working on modeling the pressure field associated with injection in the Arbuckle and evaluating what its relationship is with earthquakes in south-central Kansas,” she said.

Bidgoli, who is also an assistant professor at the University of Kansas, said preliminary results show that seismicity is moving outward from where much of the active disposal is occurring to a greater degree than previously thought.

“Our work suggests that there may be larger hydrodynamic adjustments taking



Bidgoli in the field with colleagues.

place,” said Bidgoli.

Bidgoli said the potential for problems for places like Kansas (and Oklahoma, for that matter) will be profound and, excuse the expression, structural.

“I grew up in California and was shocked to find so many masonry buildings here in the Midwest.

Californians construct their cities, neighborhoods and homes with earthquakes in mind,” she said.

And this seems peculiar to the Oklahoma/Kansas region.

“There are many places where these same technologies have been employed without issues,” she said, and here she mentioned development of the Bakken in North Dakota.

The debates on the causes and effects are fairly well established by now, so that’s not the issue.

“This phenomena of injection-induced seismicity is well known and has been documented in the scientific literature for some time, with one of the most famous examples being the work by Healy and others in 1968 on injection-related earthquakes at the Rocky Mountain Arsenal in Colorado.”

As with most things, though, it’s all in the timing.

“The models we are working on are focused on understanding subsurface pressures and how pressure evolves with time,” Bidgoli explained. “The geologic models incorporate reservoir

property data and analyses from wells in Harper and Sumner counties in Kansas, where recent seismicity in the state has been concentrated, and use those properties to simulate fluid flow and pressure changes in the Arbuckle and Precambrian basement. What our preliminary results are showing is that pressures and seismicity are extending beyond areas of concentrated, high-rate disposal. At this time, our analysis suggests that the criteria for what is normally considered an injection induced earthquake, may be more complicated.”

“Frac’ing operations can also induce earthquakes, but the operational window for such activities at a well site is usually short (hours/days) compared to disposal operations (years),” she added.

For a place like Kansas, that’s a new challenge, a new danger.

“Although Kansans are no stranger to natural hazards, the steps you need to take to be prepared for a tornado are very different from those needed for strong ground shaking related to earthquakes. And for Oklahoma and Kansas, we have a combination of factors that play into the current seismicity,” even if the exact dynamic is not yet known.

“We are in uncharted territory when it comes to well management and earthquakes. Some studies, for example a recent paper by McNamara and others on the 2014 Cushing, Oklahoma

earthquake sequence, suggest that wastewater reductions can potentially manage seismicity. This conclusion is also supported by the reductions in magnitude 3.0 and greater events in Kansas following state-ordered volume cut-backs,” Bidgoli explained.

These kinds of analyses, she said, must be done on a case-by-case basis because the reservoirs and faults in question are deep underground and their properties are uncertain.

“Factors like a fault’s orientation, the orientation and magnitude of regional stresses, pore pressures and rock properties must be accounted for in an assessment of this kind. For some faults, those not well aligned with crustal stresses, you can inject very large volumes of fluid near them without issue. For others that may be primed for slip, very small changes in pressure can trigger slip and induce earthquakes,” she said.

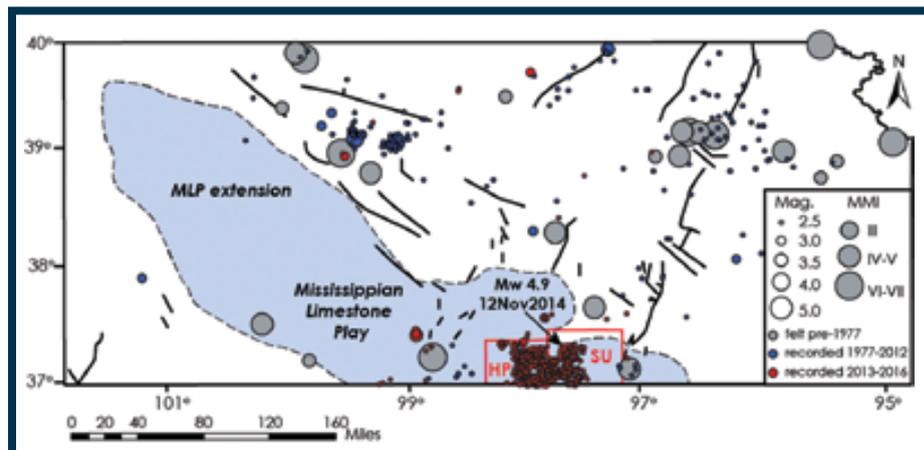
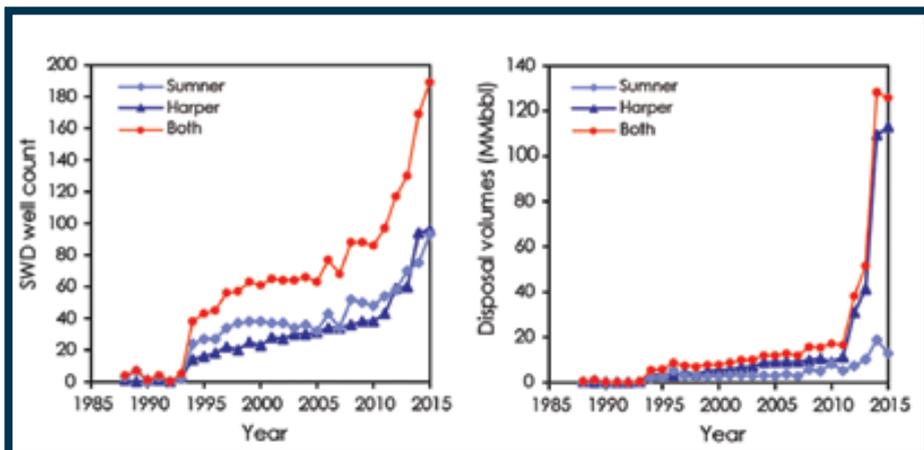
Risk Management Implications

She said the risks of induced seismicity will increasingly have an effect, not just on public safety concerns, but, obviously, the economic benefits of the oil and gas industry in the way of jobs and revenues. And since activity on one side of the border, say in Pawnee, will affect residents and commerce on the other side, say in Kansas, cooperation is a necessity.

“I think a good starting place is with the media. Our media are powerful agents for information. Beyond that, I think state and local emergency management centers will need to take a proactive role in informing the public on the ways to secure their homes and businesses in the event of a strong earthquake. State leadership should also encourage participation in programs like Great ShakeOut Earthquake Drills, which are organized so that residents, schools and businesses can practice what to do during earthquakes and improve their preparedness.”

“There is no one-size-fits-all approach.”

Bidgoli participated in a National Academy of Sciences, Engineering, and Medicine roundtable in Washington, D.C. in the beginning of December. The focus was on unconventional hydrocarbon development and she was a panelist for a session on induced seismicity, focused on developing strategies to manage risks. [E](#)



Downhole Testing Facility Completes Expansion

By KEN MILAM, EXPLORER Correspondent

So you have a great idea for a new downhole device that you think will help save money and increase production – if it works.

Where do you test it?

One of several facilities worldwide is the Catoosa Test Facility (CTF) in Pawnee County, west of Tulsa, Okla.

CTF recently completed a \$2.5 million expansion that will double borehole testing capacity for oilfield manufacturers in the research and development phase of new product development.

The facility added a second rig that will allow 18 additional test wells.

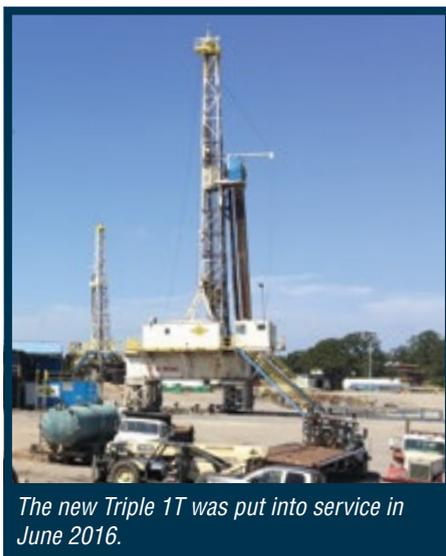
“Before, we could pull 200,000 pounds (of drill string). Now we can pull up to 555,000 pounds,” Facility Manager Dale Arnold said.

“We can test just about anything they want to test. Some of these new tools are big. Now we can do big hole tests,” he noted.

“Technology-focused companies who are developing new tools and instruments prefer real world test conditions instead of simulations in a laboratory. The new rig allows us to create new jobs and expand our testing capacity with a variety of cased boreholes up to 20 inches wide and 2,000 feet deep,” Arnold said.

Developing the Tools

CTF was formed by Amoco 30 years ago. Private investors purchased the company in 2011 and made testing services available to major oilfield companies including National Oilwell Varco,



The new Triple 1T was put into service in June 2016.

Halliburton, Schlumberger, Weatherford, General Electric, Enventure, Chevron and Shell. CTF can test 24 hours a day, seven days a week.

“We have all the majors and operators in China, Canada, Belgium, the Netherlands, North Sea companies – wherever they’re drilling,” Arnold said.

The area’s geology is the same found throughout Oklahoma.

“We have all the zones here, just shallower,” he explained.

Arnold said much of today’s testing involves horizontal drilling to develop new steerable tools and measurement while drilling (MWD) and logging while drilling (LWD) devices.

“All companies are trying to develop horizontal tools that keep you on target and

in the zone of interest,” he said. “They want to stay in a zone with the highest porosity and greatest permeability, looking for maximum production.”

Most of the work is “top secret” and “extremely sophisticated” as companies search for any edge on the competition, he said.

While he couldn’t discuss specifics, Arnold said much of the testing involves offshore operations. A major service company recently finished testing a new device and, “We’d bet it’s going offshore because of what we did with it.”

There are good reasons for real-world testing, he noted.

“We tested some weird tools that don’t work,” he said with a chuckle. “They go home with their tails between their legs. It would have been a good idea – had it worked.”

The industry downturn has had mixed effects of research and development, he said. “It depends of the company. Some have had their budgets cut drastically; others seem to be going ahead. But everybody’s watching costs now.”

Arnold said CTF has been offering discounts. “They can’t exceed their budget but they need so many days of tests, so we have been helping them out,” he explained.

The facility does not test hydraulic fracturing-related technology.

“If we put in a lot of fracs it would ruin our whole site,” Arnold said.

However, “We have discussed a new type of frac’ing (a company) is trying to design and patent that we could do here. It’s in discussions,” he added.

Other Operations

Pawnee County has been the site of earthquakes believed to be related to wastewater disposal wells.

“We’ve been in discussion with the Oklahoma State University Geology Department and we’re trying to put funding together to drill a basement well for seismic monitoring,” Arnold said.

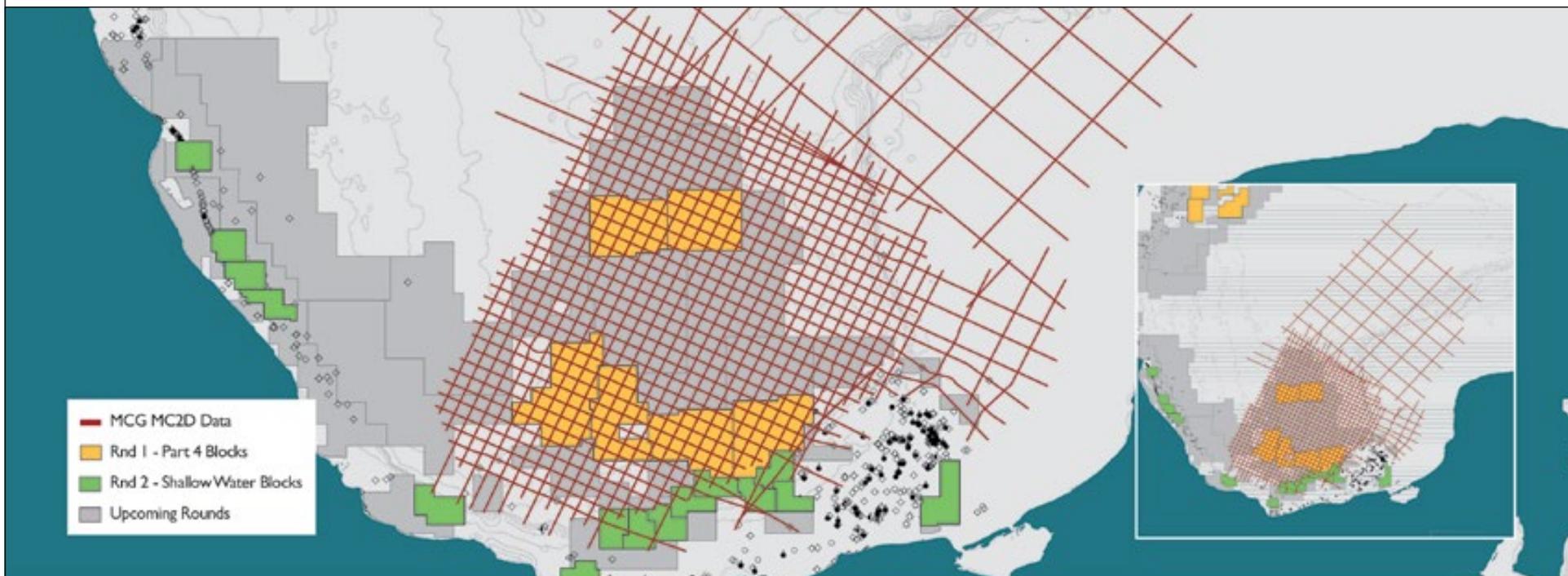
In addition to its regular operations, the facility also hosts tours for students, academics, geological and other professional associations, he said.

“Many of the people we deal with are unfamiliar with the drilling process itself,” he explained.

The site has 22 employees, the majority of them rig hand and tool pushers, Arnold said. Most of the employees have 10 years or more and some up to 40 years in the field.

Both of CTF’s research rigs use a pivoting rail system to move between test wells drilled to different stratigraphic formations and casing sizes, which provide clients with a variety of operating conditions. Both oil and water-based mud is available. Examples of testing include rotary-steerable tools, test loops, solids control, wire lines, bits, fishing tools, MWD’s and almost any downhole device.

The company’s engineering department oversees drilling operations, coiled tubing operations, an onsite mud laboratory, fabrication shops and a confidential customer data room where clients monitor testing. [E](#)



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Overcoming Seismic Challenges in Saudi Arabia

By LOUISE S. DURHAM, Explorer Correspondent

Significant advances in the technology surrounding 3-D seismic data through the years no doubt have encouraged many observers to view this major component of E&P to be just a routine piece of doing business.

It's a highly complex routine, both at sea and on land.

Three-dimensional seismic data acquisition survey design, techniques and data processing are crucial aspects of the process overall. Even when this all works, a survey might provide unsatisfactory results.

For example, the target to be imaged could lie deep within the ground, but complexity in the near surface geology can interfere with



GIROLDI

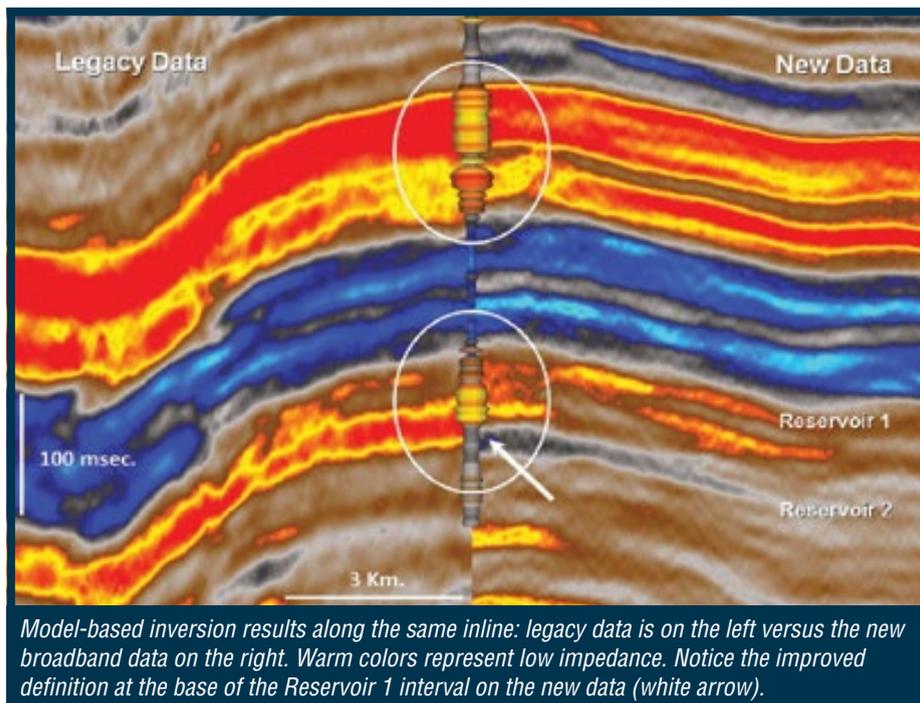
the seismic signal. With land surveys, the surface itself can provide obstacles in the form of buried soft layers of sediment, surface dunes and irregular topography, among other hindrances to acquisition of usable data.

Saudi Arabia is known to be a challenging region for land seismic.

But challenges are meant to be overcome.

"Several broadband, high density, full azimuth 3-D land seismic surveys have been acquired recently in Saudi Arabia, over producing fields and exploration areas," said Luis Girolodi, geophysical consultant at Saudi Aramco.

"In those surveys, increased bandwidth, improved signal-to-noise ratio and better subsurface sampling have had a beneficial impact on both qualitative and quantitative interpretation of the data," Girolodi noted.



Model-based inversion results along the same inline: legacy data is on the left versus the new broadband data on the right. Warm colors represent low impedance. Notice the improved definition at the base of the Reservoir 1 interval on the new data (white arrow).

He emphasized that recording of lower frequencies significantly improved the interpretation of deep levels, enhancing both the structural clarity and the resolution of the seismic data along with faster, more accurate performance.

In addition, improved, more-data-driven seismic inversion turned out to be a reliable indicator of subsurface heterogeneity both laterally and vertically, away from well control.

Eastern Province 3-D Land Survey

Girolodi and colleagues have provided an overview of a broadband, high density, full azimuth 3-D land survey, which was acquired in 2011 over a producing oil and

gas field in the Eastern Province of Saudi Arabia.

The survey was laid out to test a combination of point receiver sensors and a distinctively designed low frequency sweep for utilization in improved reservoir property prediction.

For the uninitiated, point receiver acquisition entails recording traces from individual receivers instead of tallying the responses of a group or array of receivers prior to recording the aggregate trace.

Once processing was complete, analysis of the new 3-D seismic data volume indicated a bandwidth increase with improved signal-to-noise ratio when compared to legacy 3-D data, according to Girolodi.

He noted specifically that the interval of the deep main clastic reservoirs of Permian age displays a 3 to 45 Hz frequency range at -12 dB in the new data compared to 8 to 25/30 Hz frequency range at -12 db with the legacy data.

The new dataset garnered high marks in the interpretation process, proving to be less complex, more accurate and faster than the legacy package.

In fact, large parts of the new survey enabled a more continuous and coherent interpretation to be made while preserving structural detail. In contrast, the legacy 3-D has poorer event continuity and tracking overall.

"The new dataset is fully interpretable and is able to clearly image the subsurface below 3 seconds two-way time," Girolodi said. "Structural attributes applied on the band-limited new data delivered sharp definition of the deep seated tectonic elements affecting the area."

He noted that at the end of the day, the interpretation of the new broadband, high density, full azimuth 3-D land survey demonstrates the beneficial impact of the increased bandwidth and improved signal-to-noise ratio of the seismic data.

"The recovery of low frequency signals has dramatic implications for seismic inversion as less reliance can be placed on the initial model," Girolodi explained, "and in the interpretation of deep levels, improved structural clarity and resolution can be achieved."

"This dataset has richer information on the low end of the frequency spectrum and, as a result, there is less uncertainty on the initial model when performing model-based acoustic impedance inversion, resulting in improved fidelity for determination of reservoir properties."

EMLA from page 9

meters into the Mime formation, a thin, calcareous marl that covers the entire Staffjord reservoir. Using EMLA, the resistivity increase above the formation was detected by inversion 9 to 10 meters ahead of bit, and the total-depth section was set as planned.

Geosteering involves directional control of drilling based on the results of downhole geological logging measurements. Landing a hole in a specified parameter

or stopping overburden drilling at a point determined by information about downhole geology is a practice known as "geostopping."

Look-ahead capability for geostopping drops off as angle-of-incidence increases, and falls to zero at angles beyond 40 degrees for the deepest tool configuration using previously existing technology, the researchers stated.

Using the EMLA tool, they said, "we for the first time in the industry can sense and evaluate resistivity contrasts from several meters to tens of meters ahead of bit, making geostopping feasible for all

incidence angles."

Having a preliminary understanding of downhole geology and calibrating the EMLA tool are essential to successful implementation. Accuracy also increases when detail about the formation already drilled is included in the inversion.

Ultra-high harmonic resistivity (UHR) responses are the key to look-ahead sensitivity and need to be fully calibrated, the researchers noted.

"Since calibration of deep directional resistivity tools such as EMLA is practically impossible on the surface, the calibration of UHR responses is done downhole,

using the look-around inversion. The inversion is performed on a long data interval, at least three times the longest EMLA spacing," they said.

With more accurate LALA capabilities, the industry can proactively react to changes in resistivity properties several meters ahead of bit, according to the researchers. New tools will have additional benefits, like selection of coring points, detection of base salt or oil-water contact.

At this point, in getting information about downhole geology while drilling, we might be just a few steps away from LALA land.

Hostile Conditions from page 11

Sercel

GeoWave II was the industry's first digital multi-level array specifically designed for high temperature, high-pressure wells. Initially announced by Sercel in late 2014, the array can acquire data continuously at temperatures as high as 405 degrees Fahrenheit. It is pressure rated to 25,000 psi/1,725 bar. It is optimized for seismic surveys and microseismic applications, according to the company, which noted that it is the most versatile tool, permitting operations downhole to be implemented in any well type having a diameter between 3 and 22 inches. It's compatible with

downhole tractor systems for deployment in exceedingly deviated and horizontal wells.

"The new GeoWave II is our response to the E&P industry's growing need to deploy larger arrays in more hostile conditions for applications ranging from microseismic monitoring in deeper shale plays to 3-D VSP (vertical seismic profile) surveys in challenging environments," said Sercel CEO Pascal Rouiller.

Weatherford

Early in October, Weatherford International announced the official launch of its Compact formation sampler, a slim profile wireline tool that can capture up to three 700 cubic centimeter samples in an expansive

range of borehole sizes. The svelte profile separates the tool from other pressure-volume-temperature samplers on the market. It can be run past restrictions less than 3 inches and operate in boreholes as large as 14 inches. The self-centering design significantly reduces formation-sticking jeopardy, allows a more efficient and faster connection with target zones and makes it possible to deploy the tool on traditional wireline or through drill pipe, according to the company.

"By enabling a simpler and safer downhole deployment, the Compact formation sampler helps operators more assertively regain access to representative reservoir fluids," said Olivier Muller, global vice president of wireline and testing services at Weatherford.

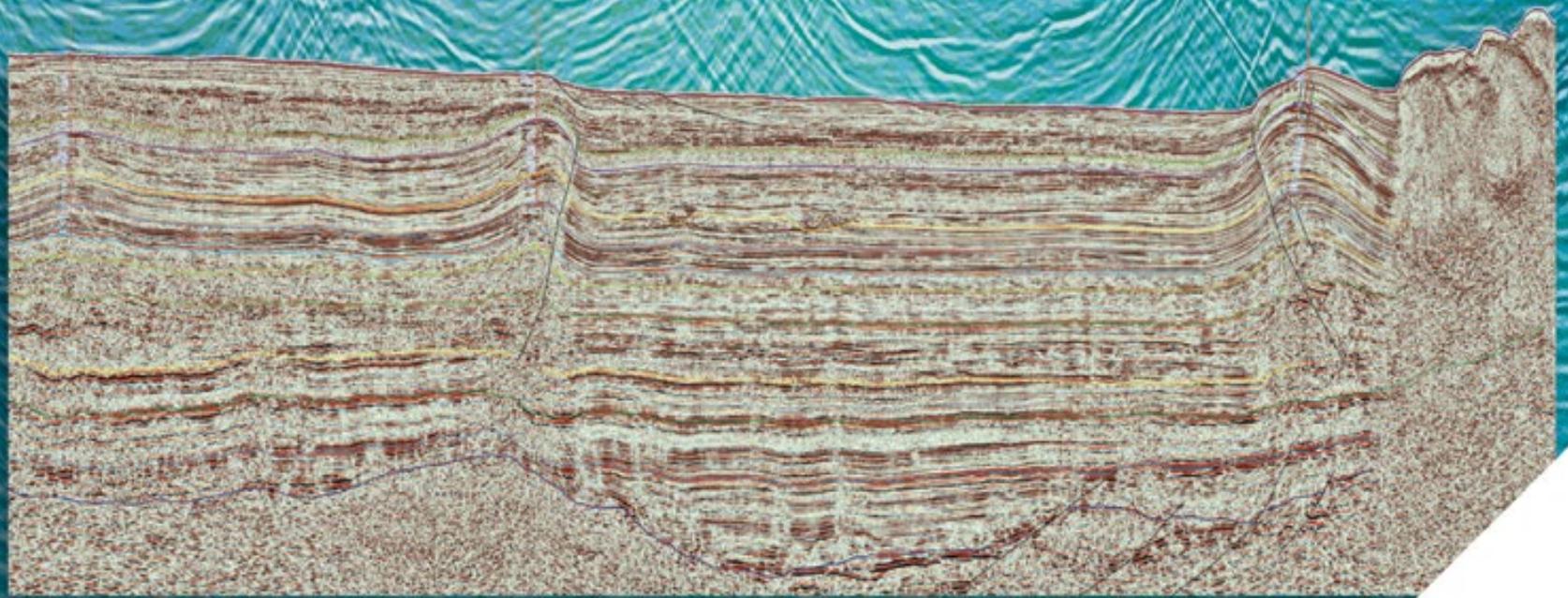
Chesapeake Energy Corp.

Given that shale continues to be a shining star lighting up the U.S. oil patch, it likely was no surprise to some operators when Chesapeake Energy Corp. recently spawned what is being touted in some quarters as the "era of the monster frac." This so-called new era debuted with Chesapeake's announcement that it set a record for fracturing when it Halliburton pumped more than 25,000 tons of sand proppant into a natural gas well in the Haynesville formation in north Louisiana, quickly dubbing it "propageddon." Jason Pigott, vice president of operations at Chesapeake, noted that output from the well increased 70 percent over traditional fracturing techniques.

Pigott is on record as saying "what we're doing is unleashing hell on every gas molecule downhole."

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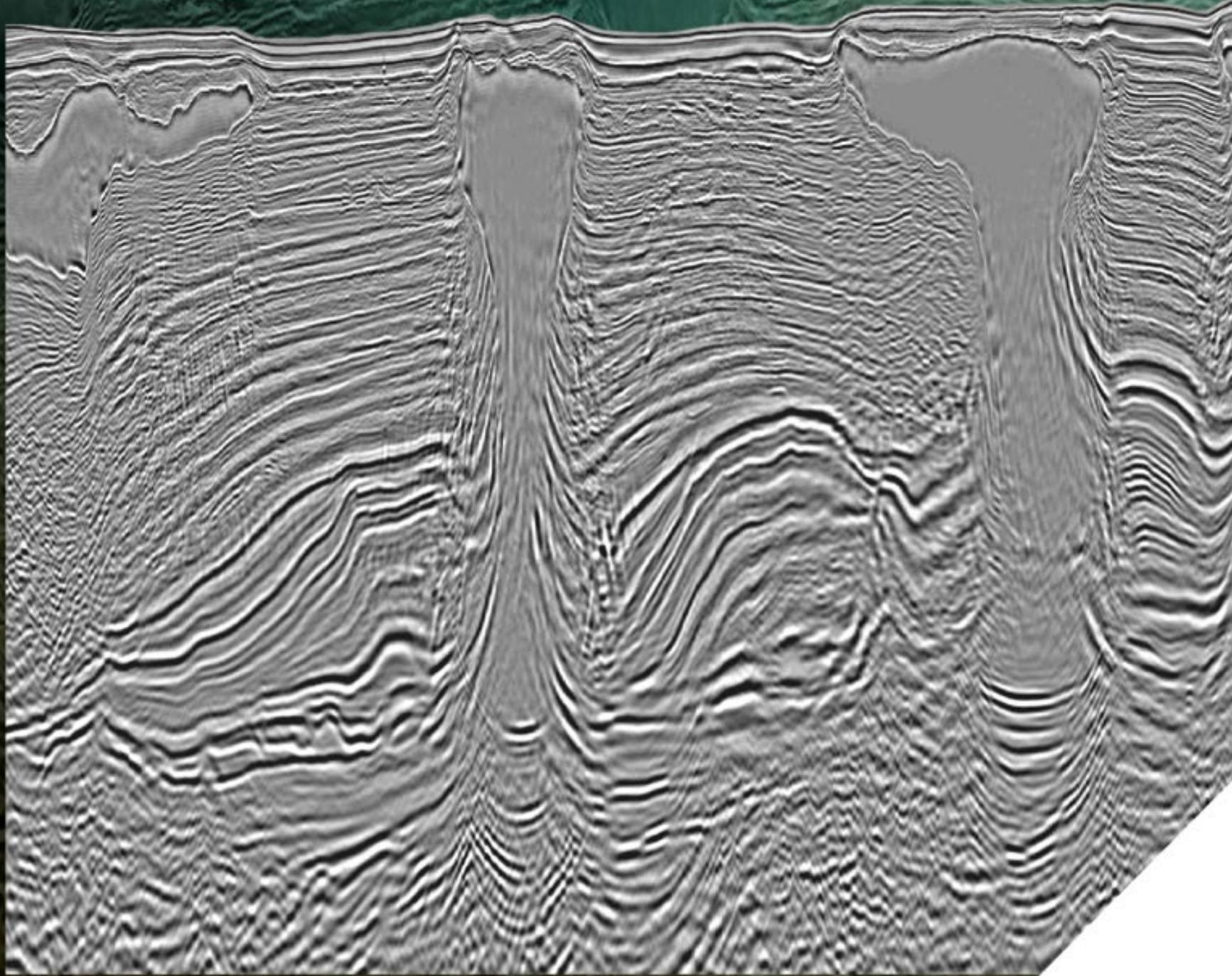


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A Natural Gas Revolution in Colombia

By MIGUEL RAMIREZ

We all know the use of natural gas not only improves air quality by reducing smog, but also helps mitigate the impact of climate change by significantly reducing emissions. Natural gas has tangible positive effects on people’s lives around the world.

Here is just one example from Colombia.

One of the meanings of the word “revolution,” as defined by the Merriam-Webster dictionary, is “a sudden, extreme, or complete change in the way people live and work.”

For Maria Giraldo, a poor woman living in a poor neighborhood of Medellín, Colombia’s second largest city, the day she began cooking using natural gas was indeed revolutionary. For her, natural gas represented a sudden, extreme and complete change in the way she lived.

Prior to the introduction of natural gas to the domestic market, Maria, like millions of Colombian housewives, cooked using “Cocinol,” a notoriously flammable liquid, akin to gasoline, which caused innumerable tragedies. The front page of *El Tiempo*, Colombia’s largest daily newspaper, published on Nov. 29, 1993, read, “Cocinol is the Fuel of Tragedy: Figures do not lie. In Bogotá alone, every four hours a patient (many times a child) is hospitalized due to burns or other injuries involving Cocinol.”

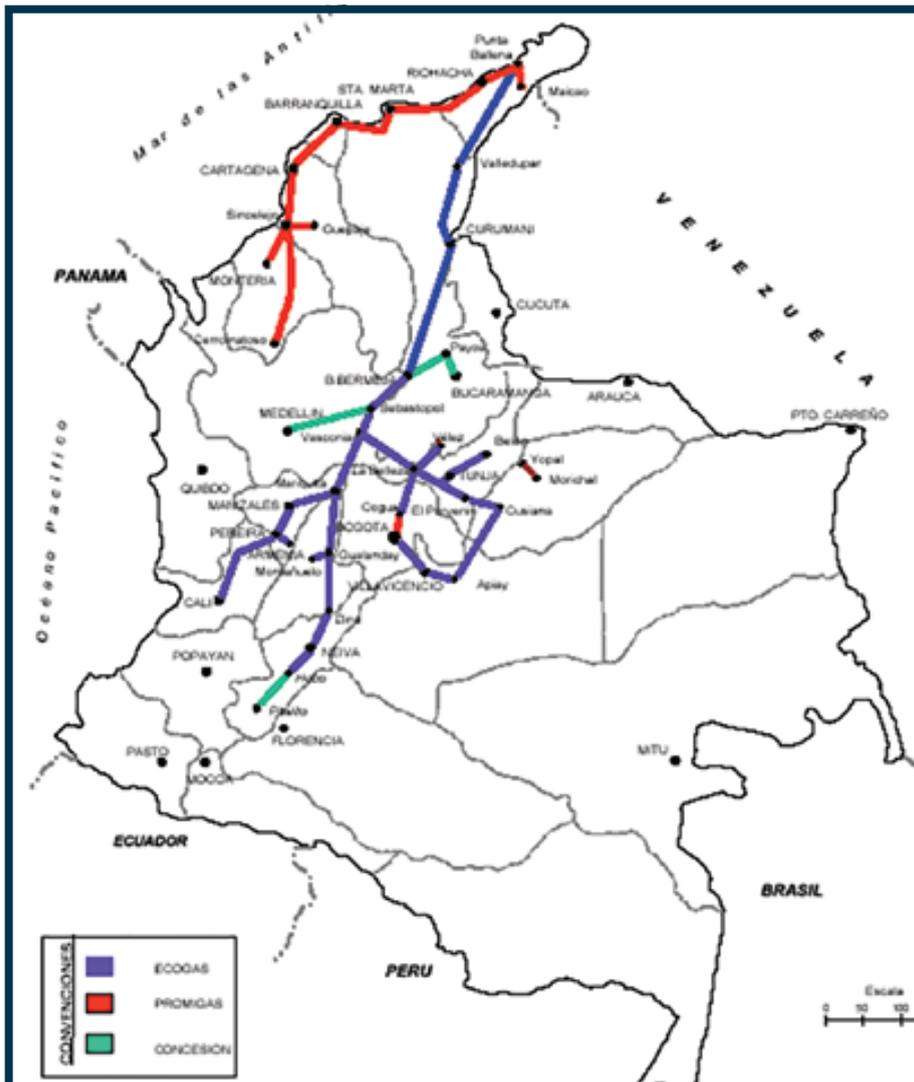
To cook using natural gas and not Cocinol was indeed a true revolution that produced a great improvement in the quality of life of millions.

For many other poor Colombians living in rural areas and in small towns, the situation was even worse. Burning biomass and wood was the cheapest way to cook. Burning wood often was not only detrimental to the health of women and children exposed to smoke in kitchens, but also hurt the environment, as evidenced by increasing deforestation.

Fortunately, now, all that is in the past.

“We do not have oranges, but we have lemons!”

Maria’s happy story is the culmination of a long saga, which describes how the implementation of the natural gas service significantly increased the wellbeing of many Colombian households and



Map of Colombia showing major natural gas lines bringing natural gas to consumers in the country’s main cities. Colombia has more than 7,200 kilometers of gas lines.

improved the competitiveness of industry and the electricity sector.

Like in other oil and gas producing countries, Colombia did not use its natural gas. For many years, gas was unwanted and, in most cases, was flared at the wellhead. It was not until the early 1970s that Colombia understood that natural gas was not an undesirable byproduct of oil production, but an asset with numerous industrial and environmental benefits.

It is worth recalling the now legendary expression of the disappointed Texaco Petroleum Company geologists, testing a large offshore prospect believed to

contain oil in June 1973, when they reported to headquarters, “Shit, it’s gas!” They were referring to the production tests that led to the discovery of the offshore Chuchupa gas field, Colombia’s largest, which along with the neighboring Ballena and Riohacha gas fields, had original reserves of approximately 7 trillion cubic feet (TCF).

Chuchupa gas reserves provided Colombia a golden opportunity to increase the use of natural gas in the country.

Juan Francisco Villarreal is a former president of Ecopetrol and one of the

drivers of the push for the wider utilization of natural gas. In 1976, he coined a phrase that captured the imagination of the industry: “We do not have oranges, but we have lemons!” He was referring to the meager oil reserves of the country as compared to the size of the gas discoveries in Guajira.

Current Status

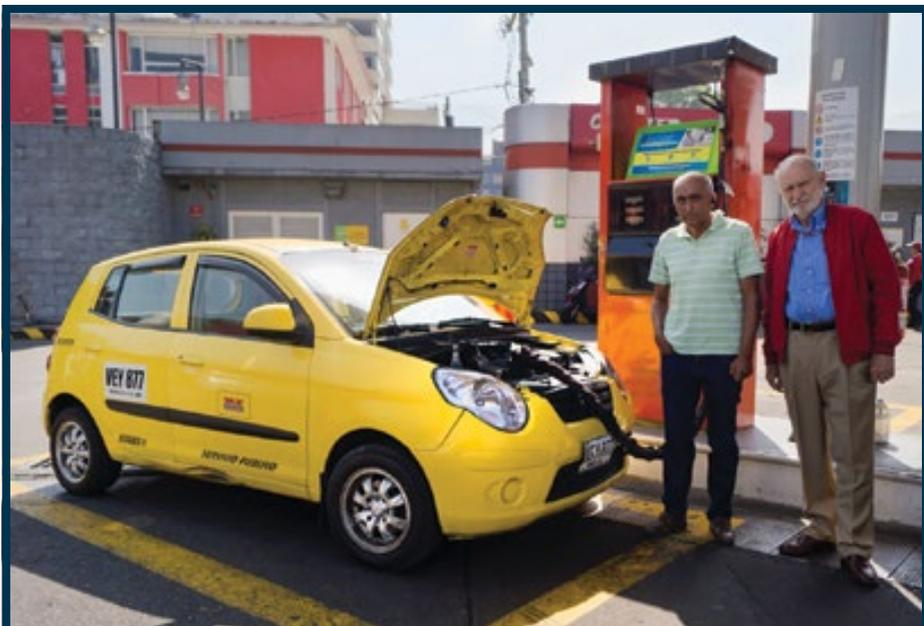
The gradual, though at times slow, penetration of gas usage in Colombia is a success story, considering that the gas reserves of the country are modest (5.9 TCF proven and probable reserves at year-end 2015) and total gas sales are in the order of 1,150 MCFGD. Other countries in the region with larger gas reserves can take cues from how Colombia increased the use of natural gas with great benefits for the population.

Today, after a difficult and long process, more than 670 municipalities, out of a total 1,123, are connected to the gas grid. Included in the 670 municipalities are Colombia’s largest cities: Bogotá (7.8 million people), Medellín (3 million), Cali (2.4 million) and Barranquilla (2.5 million). Thus, more than 8 million households use natural gas. This represents a whopping 81 percent of the total households in the country. The country’s current government aims to connect another million households to the grid before 2018.

A total of more than 530,000 vehicles, 14 percent of the total vehicle fleet of the country, are powered by natural gas. Roughly 32 percent of the taxis in Bogotá run with natural gas, and service stations serving compressed natural gas (CNG) for vehicles are now a common sight throughout the country. In addition to environmental benefits, the use of CNG also brings considerable economic benefits. Mauricio Hernández, a Bogotá taxi driver, said he saves around 50 percent when using CNG as compared to the cost of gasoline.

All service stations with CNG are privately owned, including national and international operators. Colombia has the seventh largest fleet of gas-powered vehicles in the world. (Iran has the largest,

Continued on next page



Miguel Ramirez, AAPG Member since 1972, meets Bogota cab driver Mauricio Hernandez, while his vehicle is being refueled with CNG. Mauricio said he refuels every day and saves about 50 percent as compared with the cost of gasoline.



When Maria Giraldo, a poor woman in Medellín, started using natural gas to cook, her quality of life took a quantum leap for the better.

Continued from previous page

with 3.5 million vehicles.)

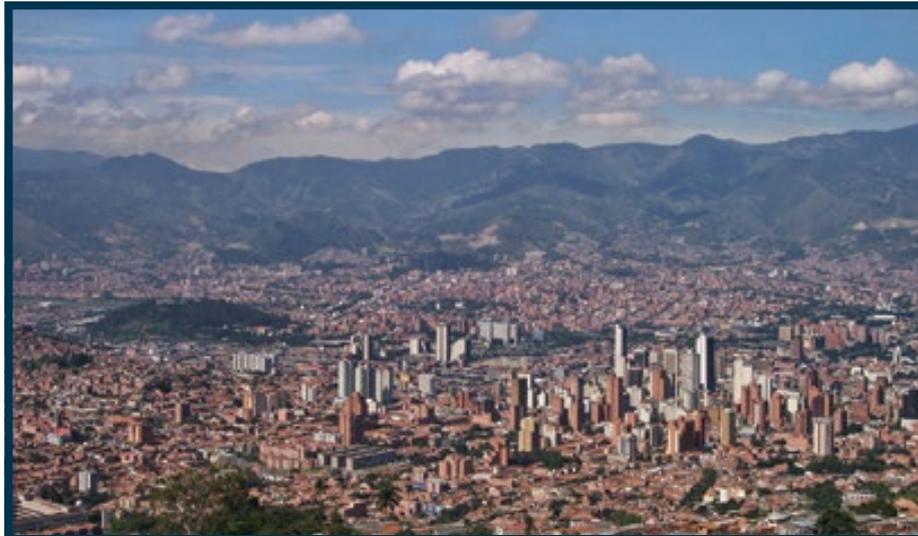
Vehicle conversions to CNG increased at a rate of 12 percent per year on average from 2010 to 2014. The penetration of natural gas in the transportation sector continues to increase. For example, Medellín's rapidly expanding bus rapid transit (BRT) system (currently more than 320 buses) runs on CNG. Recently, Medellín garbage trucks also began using CNG. Now the trucks not only emit fewer pollutants but also produce lower noise levels. Cartagena's BRT system, which came online in early 2016, also uses CNG.

CNG brings multiple benefits to motorists and cities, which enjoy lower costs, compared to diesel and gasoline-powered vehicles and lower gas emissions. The winners are the environment and consumers' wallets. Colombia's grid of more than 7,200 kilometers of natural gas pipelines serves not only domestic markets and the transportation sector, but also the power generation and chemical industries.

How Did All This Happen?

Four factors led to the expansion of the common use of natural gas in Colombia. All of these actions are reasonable and logical, but are difficult to implement, particularly in third-world countries.

- ▶ The creation of a legal and regulatory framework, which allowed private companies to participate in public utilities with clear and transparent rules, under the supervision of a single government watchdog.
- ▶ A long-term energy policy that



Medellín, Colombia's second largest city, is located in the Aburrá Valley of the Andes Mountains. The city is among more than 670 municipalities connected to the country's gas grid, which amounts to 81 percent of Colombia's total population.



RAMIREZ

Miguel Ramirez is a native of Colombia and a proud Member of AAPG since 1972. He holds a bachelor's degree in geology from the Universidad Nacional de Colombia and a master's in petroleum geology from the Colorado School of Mines. He worked for ExxonMobil affiliates in Latin America for 35 years, including E&P assignments in Colombia, Brazil, Venezuela, Peru, Bolivia, the United States and Mexico. He retired in 2008 and worked another four years as a contractor for ExxonMobil in Colombia. Afterward, he consulted for Avanti Energy. Ramirez currently lives in Bogota, Colombia.

encouraged action in the entire value chain: an adequate supply of natural gas, the construction of the transportation and distribution infrastructure required to serve the markets, and clear government signals designed to create a culture of gas utilization.

- ▶ Active involvement of the private sector in the value chain, from the

upstream to the midstream to the final distribution of gas to the consumers: The two largest gas transportation companies are Promigas (a Colombian company) and Spain's Gas Natural Fenosa, and the final distribution local lines are owned by numerous companies, most of them Colombian. The largest producers of natural gas in Colombia are Chevron,

Ecopetrol (the state oil company), Equion (a joint venture of Ecopetrol and Repsol) along with Pacific Exploration and Production.

- ▶ Continuous support of mayors and governors to expand the distribution lines in their cities: These are key actors along the entire chain and, without their support and participation, the construction of the intra-city distribution lines would be impossible.

What's Next?

For the natural gas revolution to continue bringing benefits to industry, power plants and the people of Colombia, new gas reserves must be discovered and brought to the market. This is particularly true considering the country's small proved reserves. Recent deep-water gas discoveries in the Caribbean (Orca -1 by Petrobras, Ecopetrol, Repsol and Statoil as well as Kronos-1 by Anadarko and Ecopetrol) provide encouraging technical results, but it will take some 10 years for these fields to be on stream.

In the meantime, recent smaller gas fields are being developed, gas lines are being expanded and most recently a 400-MCFGD regasification plant was approved to be built in Cartagena on the Caribbean coast. All these actions will guarantee a flow of gas to a growing market of satisfied customers.

Colombia's natural gas revolution illustrates how proper political decisions can move a developing country from a culture of "no market, no exploration" to a virtuous cycle of creating demand that stimulates exploratory efforts.

Time will tell whether other countries will follow Colombia's lead and benefit the many Marias and Mauricios living in their cities.

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Benefits from Pattern Recognition and Visualization

By TAO ZHAO and KURT J. MARFURT

The need to effectively utilize the information in an ever-increasing number of seismic data volumes can easily overwhelm the interpreter. However, recent developments in pattern recognition-based seismic facies classification (clustering) provide a means to analyze multiple seismic attributes in a single volume, either by color-coding seismic facies seen by the machine in an “unsupervised” fashion, or in an interpreter-driven, “supervised” fashion by extracting hidden relations between the attributes and a desired target property.

There has been extensive research in adapting pattern recognition techniques to seismic facies analysis, however the “soft” skill of visualizing and communicating the result to normal audiences is still more or less a privilege of the most experienced experts.

In this article, we use a Barnett Shale survey to show not only how to perform an unsupervised classification with multiple seismic attributes, but more importantly, how to effectively visualize the result.

Geologic Features and Attribute Expressions

In the western portion of the Fort Worth Basin, the Barnett Shale lies directly on top of the dolomitic Ellenburger formation. Karst and joints that extend upwards from the water-saturated Ellenburger into the Barnett Shale pose drilling and completion hazards. We use spectral decomposition, geometric and texture attributes to illuminate the architectural elements presented in the shallow part of the Ellenburger formation (figure 1).

Karst collapses appear as a circular feature with positive (red) on the perimeter and negative (blue) in the center in both structural and amplitude curvatures, with amplitude curvature being more sensitive to subtle structures (blue arrows in figures 1a and 1b). Clusters of collapse and fractures are delineated in both structural and amplitude curvatures (yellow arrows). On the image of peak frequency modulated by peak magnitude (figure 1c), we observe that karst collapses exhibit lower frequency compared to the surrounding area, possibly due to the non-specular scattering from the chaotic reflectors. On the same image, we use dip magnitude to represent the deformation along this surface. The dip magnitude highlights the highly karsted regions as well as faults and folds. Note that most collapse features appear to be fault-controlled (red arrows). Figure 1d co-renders gray-level co-occurrence matrix (GLCM) homogeneity with energy ratio similarity. Visually, areas that are less coherent are also less homogeneous, suggesting a more rugose surface.

These visual correlations of mathematically independent attributes for a given geologic feature provide an interactive, interpreter-driven means of selecting the most appropriate attributes for subsequent machine-driven classification.

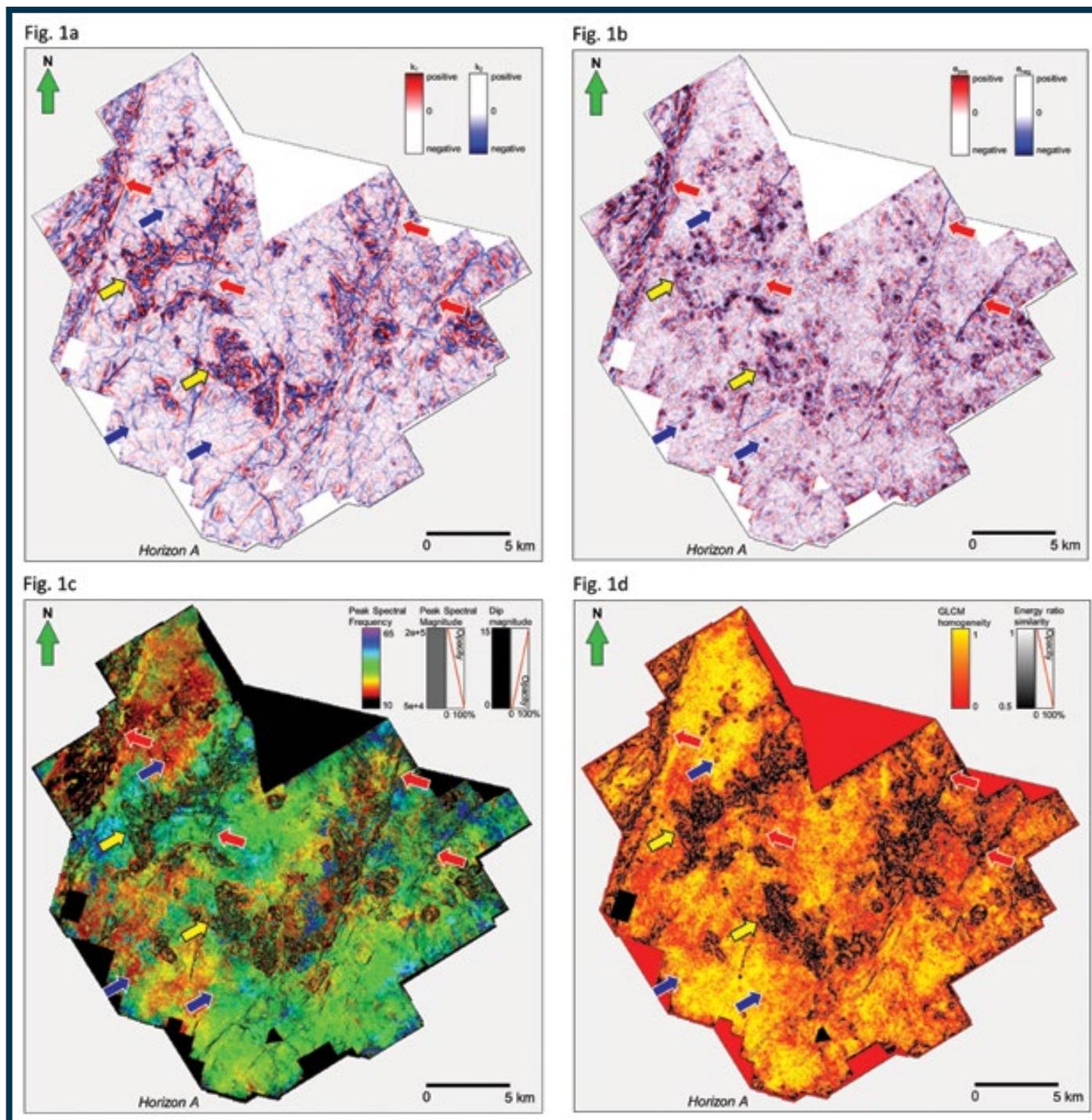


Figure 1. Attribute expressions of the Ellenburger group along a phantom horizon A 25 milliseconds below the top of Ellenburger. (a) Co-rendered most positive (k_1) and most negative (k_2) structural curvatures. (b) Co-rendered most positive (e_{pos}) and most negative (e_{neg}) amplitude curvatures. (c) Co-rendered peak spectral magnitude, frequency at peak spectral magnitude and dip magnitude. (d) Co-rendered GLCM homogeneity and energy ratio similarity. In all figures, yellow arrows represent large scale karst-collapse clusters, blue arrows very small scale collapse and red arrows regional faults.



Tao Zhao is currently a doctoral candidate in geophysics at the University of Oklahoma and a member of the Attribute Assisted Seismic Processing and Interpretation consortium.

Kurt Marfurt is an AAPG Member and professor of geophysics at the University of Oklahoma.



Unsupervised Seismic Facies Classification and Visualization

To avoid mixing geology from other formations, we perform self-organizing map (SOM) analysis within a 50-millisecond time window below the top Ellenburger surface. While interaction with crossplots of three attributes (against x-, y- and color-axes) is simple, interacting with five attributes and a 5-D crossplot is intractable. SOM starts by fitting a 2-D plane to the 5-D crossplot. Projection of the 5-D data onto this

plane provides a principal component map. SOM then deforms this plane into a curved 2-D surface to better fit the data. In order to use the display and interactivity of commercial software, we output these projected results as two volumes, one for each of the two axes of the 2-D surface. We assign two 1-D colorbars to each of the volumes, then crossplot the two volumes volumetrically. The two 1-D colorbars are designed to be two perpendicular axes of a color wheel (shown as the two dashed lines in the 2-D colorbar in figure 2), so that when

crossplotted they form a 2-D colorbar of hue versus saturation.

At this point, the results are unsupervised. The interpreter assigns meaning by carefully analyzing representative facies of interest. On the SOM facies map, the karst-collapse regions appear in purple and cyan colors, where purple corresponds to anticlinal, and cyan to synclinal components of the features. Comparing to the co-rendered structural curvature, such karst features on the SOM facies map have a higher contrast to the surrounding regions, and have a cleaner silhouette, which benefits the interpretation of karst extent. Orange colors correspond to lower frequency while yellow-green colors correspond to higher frequency non-karsted, non-fractured regions. We interpret the frequency change to be a measure of tuning thickness. In many cases, a

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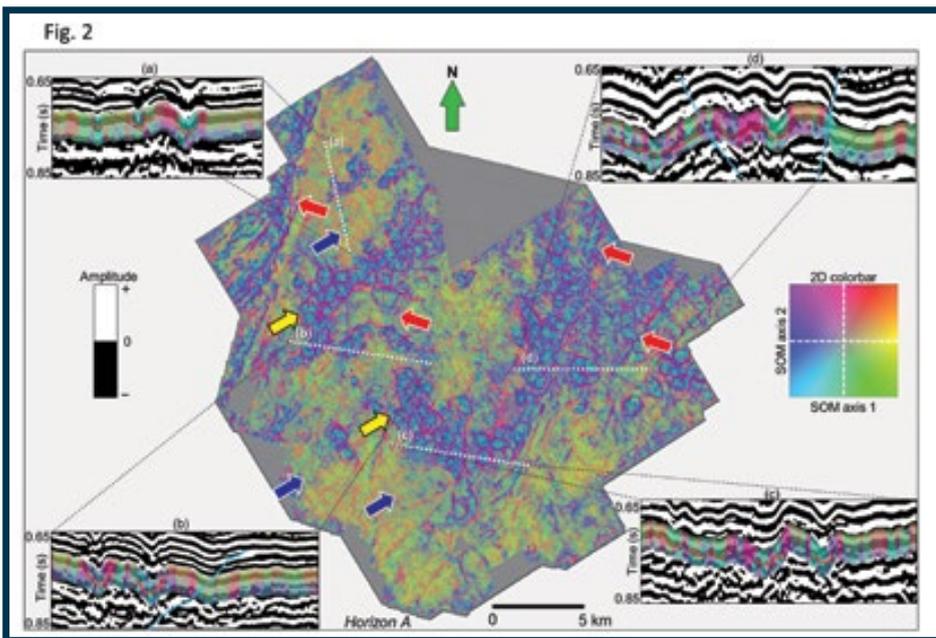


Figure 2. SOM facies map displayed along horizon A using a 2-D colorbar. Inserts (a) – (d) are composite vertical sections at four different locations comparing SOM facies and seismic amplitude. All block arrows are the same as in figure 1.

Continued from previous page

best practice is to co-render an edge detection attribute (e.g. coherence) with SOM facies to highlight the boundaries of different facies. However, in this example the karst have multiple internal edges, which overprints our SOM classification (figure 1d), therefore deteriorating the interpretability of the facies map.

To further calibrate different facies with seismic “ground truth,” we take four composite vertical sections (a) – (d), aiming to find seismic evidence of such facies. We co-render the SOM facies with seismic amplitude, and because we have to modulate the opacity of the SOM facies in order to allow the background seismic amplitude to come through, the colors on the vertical sections are faded compared to the map along horizon A. Horizon A lies vertically in the center of the SOM analysis window, so we expect to see the same facies from the horizon display shown at the center (vertically) of the colored zone on vertical sections. The karst-collapse features identified on horizon A nicely match the synclinal events on a seismic amplitude profile (marked as red curves), with the perimeter in purple (which fades to magenta on the vertical sections) delineating the extent.

We can also interpret faults from the seismic amplitude (blue curves), which are not well defined on the SOM facies because we did not include edge detection attributes as input. Most karst-collapse features developed along or in between two close faults, indicating that large scales conjugate fractures might have accelerated the dissolution process of the Ellenburger formation.

Conclusions

In this article we show how to effectively use pattern recognition techniques with proper visualization to quantify the location and extent of subtle seismic facies in a 3-D volume. Unsupervised SOM classification combines independent attributes to form a single color-coded facies map, which is then calibrated and validated with traditional seismic amplitude interpretation techniques. Crossplot tools provide a means of displaying each facies separately.

European Regional Conference set for January

The AAPG European Regional Conference, “Hydrocarbons in the Mediterranean: revisiting mature plays and understanding new and emerging ideas,” will be held Jan. 18-19 in Larnaca, Cyprus.

The event will bring together a variety of players in the area to share their experiences and ideas about the exploration potential of sedimentary basins and petroleum systems of the region.

The Mediterranean has had several very large hydrocarbon discoveries in clastic and carbonate reservoirs that vary in age from Triassic to Pleistocene. A large portion of the area is underexplored and the boost of new technology has spurred a revitalized

interest from the industry.

The technology program of the conference will cover a variety of topics and themes. The themes will include tectonic evolution; stratigraphy and reservoir characterization; petroleum systems, next exploration frontiers; geophysical methods and technologies; and drilling in the deep water and deep targets.

Aimed toward upstream oil and gas professionals, academic researchers and students, the event will serve as a learning tool and as a place to network with attendees.

To learn more about the conference or to register, visit <http://aapg.to/erc2017lc>.

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Interpretation, copublished by SEG and AAPG, aims to advance the practice of subsurface interpretation.

A New Spin on Industry Training

By COURTNEY CHADNEY, EXPLORER Correspondent

Life is supposed to slow down, leaving more time for relaxation, recreation, travel and fun and games. Some of that is true for retired petroleum geologist Marc Bond.

Instead of relaxing, though, Bond is busier than ever using his newfound free time to spread knowledge and passion for geology, and more impressively, he's doing it by playing games.

As designer, developer and implementer of the "Oil Exploration Game," Bond has created an educational tool disguised as play and designed for non-geoscientists working in the industry, as well as students at secondary and university levels.

A Brewing Idea

After years of working as an exploration geoscientist with the idea of an exploration game as an educational tool brewing in his mind, Bond created it in 1992.

"I knew several major companies had sophisticated games they used as a training tool for geoscientists, but I wanted to design something to provide an understanding of the exploration business to the non-geoscientist professionals and support staff within an oil and gas company," he said.

Bond said it was his belief that "people do their jobs better when they understand their environment. The understanding of the why behind the job is what makes it more enjoyable and easy to do."

Bond first put the game to use after



Bond (right) using his game as a training tool.

being asked to present to the new CEO of his corporation, British Gas, who had no previous experience in the oil and gas business. Using the game, Bond was able to explain everything he wanted to convey. After seeing how effective the game is as an educational tool, Bond was asked to share the game with the corporation's new hires. The game was incredibly successful communicating with geoscientists and non-geoscientists (e.g., economists, lawyers, support staff, etc.) within the company. It was much later when he realized the game's potential for expansion into an academic and educational setting.

How the Game is Played

Natasha Dowey, member of the Petroleum Exploration Society of Great Britain (PESGB), describes it as a geological version of Battleship, but "with more understanding of what you're aiming at and why."

"It makes the idea of the exploration industry fun and different, and develops some very strong messages in a short period of time," she said.

As she described it, the game is a simulation that begins with players acquiring licenses to explore hydrocarbons. The license blocks are

displayed on a map, then four bid rounds begin. Each team is given a budget to spend on buying licenses and exploring, and a balance must be found in order to achieve success. The game also involves interpreting geological data and incorporating the team's developing knowledge and intuition to make the right decisions throughout the game. After each round, well results are released and trends in discoveries are displayed on the map for all teams to see. Teams can then buy additional data for further insight. Dry blocks lose money and discoveries earn sizeable assets. After the fourth and final bid round, team balances are tallied and the richest team is declared the winner.

Players have described it as fast, fun and a tool that conveys more than just science awareness. For example, it develops important skills related to problem-solving, decision-making, team work, creative thinking and coping with uncertainties and change. Requiring minimal resources and lasting approximately two hours, the game is ideal for classrooms and corporate settings.

The post-analysis or de-briefing following the simulation is the most crucial component, allowing the facilitator to interact with participants and discuss in further detail the aspects of the exploration business that were introduced during the game. This includes prospecting, the interpretation of geological data, value of data, bidding strategy and financial

[Continued on next page](#)

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4. **Claude Rangin**, Professor, Nice University France - "New Tectonic and Geodynamic Concepts for West Sundaland (The Bengal Basin and its Eastern Margin in Myanmar and Andaman Sea) - Consequences for Hydrocarbon Exploration"
5. **Kyungsik Choi**, Professor, Seoul National University (Dept of Earth & Environmental Science) Korea - "Proximal-distal Trends in the Point-bar Architecture of Sittaung River, Myanmar: implications for the Reservoir Characterization of Meandering Rivers in the Tidal-fluvial Transition"
6. **Manuel Pubellier**, Research Director at CNRS - Centre National de la Recherche Scientifique France "Impact of Mesozoic structures on the Crustal and Sedimentary Evolution of Sundaland Basins"

Optional Post Conference Field Trip
 The Myanmar Geosciences Society will offer an optional 3-day/2-night field trip to the Kalaw Basin to visit Mesozoic sediments of Kialaw Basin and view conspicuous surface geologic expressions of Sagaing Strike Slip Fault and Shan Boundary fault (Suture Zone), as well as various Paleozoic to Tertiary outcrops along the road sections. More details from the website "Activities" tab.

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considerations. According to Bond, the concluding discussion is the most rewarding part of the game because it allows experienced professionals the opportunity to share with an already engaged audience, "inspiring interest and appreciation of exploration and the oil and gas business, and helping to train future geoscientists."

Playing at Another Level

Hamish Wilson, CEO at Minus7 and former president of PESGB, is helping to raise awareness of the game, helping Bond and sponsors PESGB, Rose & Associates LLP and AAPG promote and advance the game as a learning tool. Wilson believes the success of the game is important for the larger community because "this sort of thing has an important role in explaining oil and gas to the general public. We have an awful reputation in the public and we need to do something about it."

According to Wilson, he prefers this concept over more traditional methods, as it enables geoscientists to transcend traditional outreach models and start a conversation by "engaging with people rather than just presenting something."

During his time with PESGB, Wilson looked for tools to explain the oil and gas industry to the general public. After chatting with Bond about his game, Wilson thought it was an excellent idea and invited Bond to run the game with his PESGB staff.

It was a hit. The group of players agreed that the game would be perfect for more experienced professionals to "give back" to the industry that had been so great to them. The group felt it was easy to facilitate, grabbed audiences' attention, conveyed a complicated subject in a simple way and would nurture passion in the geosciences.

As a next step, Bond and PESGB placed an advertisement in PESGB's magazine to invite other geoscience professionals to become trained game facilitators. The turnout was great and they are currently producing copies of the game for 25 potential Great Britain facilitators.

With the game's proven success in the U.K. (receiving the United Kingdom Suggestion Scheme Gold Award and British Gas Suggestion Scheme Star Award), enthusiasm from fellow colleagues and support from sponsors, Bond knew it was destined for expansion. At that time, he was the sole facilitator and simulations had been limited to oil and gas corporations within Great Britain, however after attending an AAPG convention, Bond saw the potential to spread the game to the United States through AAPG's vast network of professionals. Recognizing that the opportunity was ripe, Bond seized the moment by gaining sponsorship and support from AAPG.

"If it is going to grow, it's got to grow beyond me," commented Bond.

Although traditionally meant for professionals working within the petroleum industry or in related activities, discussions with his wife, a teacher, inspired Bond to take the game's expansion even further. Collaborating with Maria Iredale, PESGB's executive director, Bond was able to connect with the Earth Science Teachers Association to develop the game as a curriculum for secondary schools and universities in the U.K.

"Here in the U.K. we have had a workshop where we have trained several geoscience professionals to run the game in secondary schools and universities," said Bond.

Bond and other game enthusiasts have



In the game, players simulate bidding on and exploring license blocks displayed on a map.

high expectations for the game's future. Specifically, Wilson hopes that in the coming years the game will become a "part of a tool box set of material that PESGB and AAPG members can use to take to their schools and communities to explain what we do."

They all believe this game allows geo-professionals to overcome the common quandaries of "what to discuss or present" at an event and "how to communicate the

subject to the general public," and that it will give the facilitators and geo-professionals wanting to promote their industry the confidence and opportunity for discussion and interaction, so they can share their passion and knowledge.

Bond hopes the game will expand to North America with the help of AAPG and continue to be successful, serving as a training tool for both professionals and students for many years to come.

"We are also now working with AAPG to bring this to the States, and have planned a pilot program in Tulsa with several workshops to train geoscience professionals to run the game and are also going into secondary schools and universities, scheduled for early February," he said.

Any geoscientists looking to get involved with the Oil Exploration Game as a facilitator or an ambassador can contact Bond at marcbond@roseassoc.com.

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YP Leadership Summit

YPs Focus on Correcting the Value Gap

By JONATHAN ALLEN, Young Professionals Co-Chair

The 7th annual Young Professionals Leadership Summit (YPLS) was held this October in Houston as part of the AAPG Mid-Year Business Meeting. The three-day event gives Young Professionals (YPs) a greater understanding of AAPG through workshops to discuss issues currently facing YPs within the Association, and the chance to network with current AAPG leadership.

After last year's YPLS, I wrote in the EXPLORER about the fact that many YPs do not see the value in AAPG and that they can receive many of AAPG's products and services from other sources.

Additionally, many YPs have expressed frustration that, while this and similar issues have been raised many times, the Association has yet to adequately address these problems to their satisfaction, and it directly affects our membership numbers. Membership is decreasing and the YPs are a large demographic within this decreasing population.

In response to the discussions at last year's Leadership Summit, the Young Professionals Special Interest Group (YP SIG) developed four focus areas aimed at communicating and increasing the value to both YPs and the Association. These focus areas were:

- ▶ Technical excellence
- ▶ Membership recruitment and retention
- ▶ Career development
- ▶ External partnerships



Kneeling: Nick Nelson, Matthew Rine; Standing: Meredith Faber, Hunter Lockhart, Jonathan Allen, Merrill Stypula, Matt Boyce.

Participants at this year's YPLS spent the majority of their time revisiting these focus areas. The group reviewed the programs that have been held within each focus area and evaluated each based on whether a particular program/event had provided value to YPs and the Association.

After this assessment, decisions were made to either continue or expand a program, or to discontinue it. Additionally, new programs were proposed in order to create a diverse suite of programs within each focus area.

Execution

I'm pleased to report, during the time between the 6th and 7th YP Leadership Summits, the YP SIG has been able to execute a number of programs and events that relate to our four focus areas.

Within the technical focus area, the YP SIG has held several one-day technical workshops, short courses and panel discussions. The YPs had our most ambitious program at ACE in Calgary

this year, with the YP SIG sponsoring a field trip, a focus session, the annual YP Meet and Greet and a networking reception. The YP program for GEO 2016 in Bahrain also included a packed YP program including technical and non-technical short courses, a core workshop, a meet and greet and

panel sessions.

These programs have helped the YP SIG to further our goals within the membership recruitment and retention focus area. Additionally, we have encouraged our members to become more active, communicating and raising awareness of the "student-YP bridge," and highlighted the value of the YP SIG through articles like this one.

Looking Ahead

We are also extremely excited to see the first Young Professionals Exemplary Service Award presented during AAPG's 100th anniversary at ACE in Houston next year.

Our goal for 2017 is to increase YP involvement in committees, the House of Delegates and in local/national leadership. Additionally, we will be conducting another YP survey in order to receive feedback on our current programs and performance from the entire YP population.

The YPs have also been working very closely with AAPG Director of Innovation and Emerging Science and Technology Susan Nash to help develop and promote courses relevant to YPs, especially in the current economic environment. The career development options have expanded dramatically, thanks to these combined efforts. The YPs have also been leveraging

Continued on next page



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READERS' FORUM

'Pure Fantasy'

The article "Tectonic Shocks in the Oil Industry" by Mark Mau and Henry Edmundson in the 2016 November edition of the AAPG EXPLORER brings such a distortion of geological facts that is hard to understand how such an article can be presented in an AAPG publication. Not a single one of the historical theories involving plate tectonics mentioned in the article have withstood our increasing wealth of knowledge. This can be shown for the original data interpretations like marine magnetics, or age and position of crust, data in offshore JOIDES wells, as well as for modern paleontological data (distribution of critical fossils). Modern geological facts, aided by deep seismic and deep wells, have opened our eyes to new processes, far removed from plate tectonic theory. And to claim that plate tectonics can be the basis for gas and oil exploration is pure fantasy.

I understand that today many geologists using the then new waves of geological science in the 1960s-80s now have to defend their original ideas. But this should be done with due acknowledgement of new facts and ideas. There exists today such a huge amount of data repulsing pure plate tectonic theories that indeed a new general theory name should be generated and utilized, in the line of worldwide magma-related tectonics." This would better explain and join the many clear examples of mantle anomalies being the basis of major geological events, in form of both thermal mantle domes and mantle collapses, like the Hungarian Basin, the Alps-Pyrenees, Atlas Chain, the northern Gulf of Mexico, Rocky Mountain-Andean Chain, Atlantic Ocean Basin, etc.

*J.C. Pratsch
Houston, Texas*

Hooked on a Feeling

I am writing to thank you for the article "Tectonic Shocks in the Oil Industry" in the November issue EXPLORER by Mark Mau and Henry Edmundson. I first became hooked on geology in 1970 after finishing military service and was casting about for a career. I had the good fortune to study, both in undergraduate and especially in graduate school, under dynamic professors that were up on the latest "theories" of the day and were excited about plate tectonics.

As the article indicates, this was about the time when plate tectonics was starting to receive widespread acceptance. The idea that my professors could hold a simple rock sample in their hands and integrate that rock's genesis into the entire history of the earth was fascinating to me. The trap was sprung, I was hooked, and after 40 plus years I admit I'm still hooked.

*Keith H. James
Wales, U.K.*

Continued from previous page

other YP groups, including the Young Professionals in Energy, the Society of Petrophysicists and Well Log Analysts YPs and the Society of Petroleum Engineers YPs, and we have hosted a number of joint events.

At the conclusion of the 7th annual YPLS, participants felt energized and walked away with a clear set of actions to continue developing the four focus areas proposed one year ago.

It was an exciting time in my life, and in geology too, and I thoroughly enjoyed reviewing the article as it took me back to another time and place. The article is well written such that it can be read and understood by a non-scientist. At the same time, the story is an excellent example of how science works and how multiple lines of investigation can coalesce in a unifying moment to explain the beauty of the earth around (and beneath) us.

I'll make sure my grandchildren read it.

*Connie Hawkins
Denver, Colo.*

'Not Premised on PT'

The article "Tectonic Shocks in the Oil Industry" in November's Historical Highlights begins with a review of PT history. Nothing new there, every geology student reads about it in geology texts. It continues by claiming that PT is at the heart of petroleum exploration. Is this true?

PT is firmly established. However, data reveal major flaws (for a well-referenced discussion see Pratt, D., 2000, Plate Tectonics: A Paradigm Under Threat). PT champions rarely address them. Science suffers. There are alternative ideas. They are part of PT history and geology.

In my experience, industry does not center exploration on PT. It focuses on data, analogues, underexplored areas, improved seismic acquisition/processing and drilling/production technology, imagination and experience, drilling into the unknown, risk taking, changing politics and economies.

The quoted Neftex model leans heavily on sequence stratigraphy and comprehensive integration of large databases (the web page does not mention PT). No doubt very useful, but what's new? I worked for two oil majors that used global databases, looking for overlooked basins and analogues. They were not premised on PT.

We did not spend time discussing mantle convection, partial melting of heterogeneous and streaky mantle plumes, hot spot tracks, slab pull or push, subduction zones and factories where sediments descend into the mantle and basalt comes up as andesite, the mysteries of mantle wedges, magnetic stripes or the fate of Pangaea. We focused on basin settings and evolution.

Returning to my first sentence, it is surely sad (not to mention irresponsible) that texts do not consider multiple working hypotheses. Many thousands of students are sent out into the world each year armed only with PT dogma. They should at least be presented with data so that they can make up their own minds. I think AAPG could help.

Additionally, participants of both the YPLS and the AAPG Mid-Year Business Meeting were able to see the large number of programs and events that the YP SIG has successfully executed in the last year. These programs are helping the Association to thrive well past its 100th anniversary and are making a lasting impact with the YP SIG.

To keep up to date with the YPs, follow us on Facebook, Instagram, Twitter and LinkedIn. [E](#)

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Open Rank Faculty Position in Petroleum Geology

The School of Geosciences at the University of Louisiana at Lafayette invites applications for an open-rank (tenured or tenure track) faculty position in Petroleum Geology that is expected to begin in August 2017. The rank of this position will be determined based on qualifications. The successful candidate will be expected to put together a large and dynamic research program in the area of Petroleum Geology and will mentor students at the undergraduate and graduate levels. Responsibilities will include teaching undergraduate and graduate courses such as stratigraphy, sedimentary petrology, and subsurface mapping. Experience in the petroleum industry will be a great advantage. A Ph.D. is required at the time of hire.

The School of Geosciences (<http://geos.louisiana.edu/>) houses the programs of Geology (B.S. and M.S. degrees) and Environmental Science (B.S. degree with a M.S. expected to begin in August 2017). The School includes 11 faculty members, four full time instructors, a research scientist, lab technician, and approximately 150 total undergraduate majors and 85 graduate students. There are many opportunities for collaboration with local industry, institutes, and centers, as well as within other departments and colleges, including Petroleum Engineering. The University of Louisiana at Lafayette, the leading institution within the University of Louisiana System, is a public institution of higher education offering bachelors, masters, and doctoral degrees and has a student population of about 18,000. Located mid-way between New Orleans and Houston, Lafayette is a city of more than 126,000, one of Louisiana's fastest growing areas, and is a hub for numerous cultural festivals and activities.

To be considered for this position, send as a single PDF file that includes your name in the title, an application letter, CV, separate statements of teaching and research interests, and the names and contact information (post and email) of four references to geology@louisiana.edu. The review process will continue until the position is filled. To ensure full consideration, receipt of the complete application material is required before December 12, 2016. Questions regarding this position can be directed to Dr. David Borrok (dborrok@louisiana.edu). The University of Louisiana at Lafayette is an Equal Opportunity Employer and encourages applications from minority group members and women.

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Honoring a Trustee and Exploring Hawaii

By TAMRA CAMPBELL, Administration and Programs Coordinator

Paul M. Strunk, an AAPG Foundation Trustee emeritus and an instrumental player in the creation of the successful Military Veterans Scholarship Program (MVSP), has been selected to receive this year's L. Austin Weeks Memorial Medal, the Foundation's top award.

Strunk, a successful explorationist and CEO of American Shoreline Inc. in Corpus Christi, Texas, will be honored in a special presentation at AAPG's 100th Anniversary Annual Convention and Exhibition, set for April 2-5 in Houston.

The L. Austin Weeks Memorial Medal is given in recognition of extraordinary philanthropy and service directed to advance the mission of the Foundation – a criteria that Strunk has repeatedly met for several decades.

In fact, he and his wife, Deana, have been major donors to the AAPG Foundation since 1994 (the year he joined the Trustee Associates), but it was their belief in the new MVSP – and their lead gifts to its fundraising efforts – that helped make the program a reality for the Foundation.

Thanks to their generosity, the program has a solid foundation to grow from and is now in its second year of scholarships to deserving veterans.

The Trustees recently voted to rename the MVSP as the Deana and Paul Strunk Military Veterans Scholarship Program.

Strunk served as vice chair for the Foundation Trustees in 2005 and was selected as chair in 2008. He was selected



Charles Blay led the Trustee Associates on a field trip to see the volcanoes on the island of Hawaii.

as a member of the Foundation's Members of Corporation in 2000 and appointed as a Trustee in 2011. During his time as a Trustee, Strunk served on the Foundation's Audit Committee.

He received the Foundation Trustee Associates Service Award in 2015.

Strunk stepped down from the Board of Trustees earlier this year and is now a Trustee emeritus.

An AAPG Member since 1960, Strunk served as AAPG treasurer in 1988-90. Other activities include stints on the Insurance, Environmental and 21 Century committees. He served two terms in the AAPG House of Delegates.

A Kansas State University graduate (bachelor's and master's in geology), Strunk previously received two AAPG Certificate of Merits, the Distinguished Service Award, Honorary Membership and the Trustee Associates Service Award.

* * *

The Trustee Associates' 39th annual meeting was held in October at the Mauna Kea Beach Hotel on Hawaii's beautiful Kohala Coast in October. After meetings to conduct business and learn about the AAPG Foundation activities, the group had time to take in sites of the island.

The field trip "Volcanoes of Hawaii's Big Island" was led by geologist and longtime Hawaiian Charles Blay. The day began with a stop at the Mauna Kea State Park for views of Hawaii's two largest mountains, Mauna Loa and Mauna Kea. The trip then continued to the lava fields at the Volcanoes National Park with a stop at the Kilauea Caldera.

Smaller group tours included the historic Kona Tour, where participants learned about the history of Hawaii's royal family, visited a Kona coffee farm and tasted honey from Big Island Bees.

Other activities included deep sea fishing; golf at the historic but challenging Mauna Kea Golf Course; a chance for breathtaking views on a two-hour, unforgettable helicopter tour of the island's volcanoes and waterfalls; and four-wheel drive vans were used to descend into Waipi'o Valley, forging streams to see the dramatic scenery and Hi'ilawe falls from the valley floor.

During the meeting, the Trustee Associates elected David Worthington as the group's new chair, and Jeff Lund as vice chair. Pete MacKenzie continues the second year of his term as secretary/treasurer.

The Trustee Associates are a distinguished group of donors who provide support for the Foundation's fundraising efforts, as well as providing counsel and leadership to its Trustees. Their next meeting will be held Sept. 20-24 at The Samoset Resort in Rockport, Maine. 

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Review of applications will begin January 1, 2017. The search will continue until the position is filled. The anticipated start date for the position is Fall semester 2017. Applicants can apply online at <http://apply.interfolio.com/38699>. Applicants will be required to submit a vita/resume, statement of plans for sponsored research, teaching interests, and a list of five references who can be contacted, including telephone numbers, e-mail addresses, and mailing addresses. Questions or information requests should be addressed to the Chair of the Organic Geochemistry Search Committee, at (405) 325-3253 or ougeochemistrysearchchair@ou.edu.

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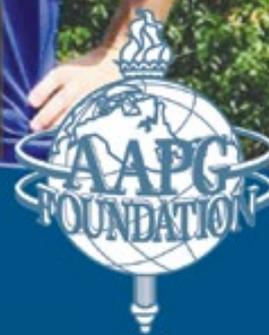
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Review of applications will begin on January 17, 2017, and continue until the position is filled. SFA is an equal opportunity employer. This is a security-sensitive position and will be subject to a criminal history check.

POLICYWATCH

Trump Wins. Now What?

By EDITH ALLISON, Geoscience and Energy Policy Office Director



ALLISON

With the smaller federal government envisioned by Trump, it is possible that more energy decisions ... will be made locally.

Energy policy was not a major topic of the presidential campaigns, but President-elect Donald Trump's positions represent a radical change from current energy policy. However, campaign statements often soften when the candidate is in office, and Trump's pledges to grow fossil fuel production will contend with global supply and demand pressures, and strong environmental opposition. With the smaller federal government envisioned by Trump, it is possible that more energy decisions – especially about regulation and infrastructure – will be made locally.

Naturally, having both houses of Congress and the White House controlled by the Republican Party should ease passage of conservative legislation. However, issues such as repealing the Affordable Care Act will occupy Congress before they consider legislation relaxing energy regulation or expediting energy infrastructure. Smaller Republican majorities and internal party disagreements will also limit congressional accomplishments.

However, Washington, D.C. first has to make it through the lame-duck congressional session and the presidential transition.

Congress must decide about funding the government after the current continuing resolution (CR) ends on Dec. 9. Possible decisions include another CR that funds the government to continue doing the same things as last year. However, Congress-watchers expected that the half-finished appropriation bills would be wrapped into a single, omnibus appropriation bill and passed in December. Another possibility is that fiscal conservatives would push for a government shutdown in support of smaller appropriations.

Many of the investment tax credits that had to be renewed each year were made permanent or multi-year in 2015. But a few, including the credit for energy efficiency improvements to homes, are likely to come up for a vote at the end of 2016. In addition, congressional leaders promised to consider a water infrastructure bill that assists Flint, Mich., this year.

Presidential Transition

A change in administration opens about 4,000 federal jobs to presidential appointments. Of these, about 1,100 – including the president's cabinet – require Senate confirmation. Cabinet appointments should clear the Senate within a few days of the inauguration. Other appointments could take a year or longer. These appointments are a major focus of the transition team.

The energy lead is Mike Catanzaro, who was an adviser to former House Speaker John Boehner and presidential candidates Mitt Romney and George W. Bush. Myron Ebell of the Competitive Enterprise Institute heads the transition team for the Environmental Protection Agency

(EPA). David Bernhardt, who worked at the Department of the Interior under President George W. Bush, is leading the transition team for Interior. Transition teams welcome nominations, resumes and policy ideas.

Trump's Energy Pledges

President-elect Trump's stated energy plan (at least at one point) would cut regulations and restrictions on fossil fuels and energy infrastructure, eliminate the EPA and cancel U.S. participation in the Paris climate accord.

Eliminating the EPA is unlikely, but a smaller EPA and fewer new regulations seem probable. It is unclear what actions a President Trump would take on the Paris accord. The formal withdrawal process takes four years. Withholding funds required to meet the U.S. commitment may be a faster option that a Republican Congress would support.

The Outer Continental Shelf (OCS) 2017-22 leasing plan is scheduled to be released this year. The Beaufort and Chukchi Sea areas could be removed from the final version, contrary to Alaskans' support for Arctic development. In addition, environmental groups want President Obama to use the Outer Continental Shelf Lands Act to permanently withdraw the Atlantic offshore from energy drilling.

President-elect Trump has pledged to open all the OCS to leasing. His administration could revise the OCS leasing plan, although that is a slow process.

Supreme Court

Having one or more Trump-nominated justices on the Supreme Court will be significant for energy policy. Next year, the Clean Power Plan is likely to come before the Court. Readers might recall that just days before Justice Scalia's death, the Court's conservative majority issued a stay, halting implementation of the Plan while legal challenges are pending. Other environmental regulations such as the Bureau of Land Management hydraulic fracturing regulations may reach the Court – the June decision by the U.S. District Court for Wyoming to strike down the rule is in appeal.

The 115th Congress

The Senate Republican majority has dropped by three to 51, and the House Republican majority is down from 247 to 239 or 240 (one Louisiana seat will be chosen by a Dec. 10 run-off). These changes should have little impact on congressional leadership or energy policy.

Congress is on track to pass about 4 percent of the 11,644 bills introduced in the 114th Congress. It is too early to know if a burst of bipartisan cooperation will lead to a more productive 115th Congress. www.aapg.org

IN MEMORY

- Dennis Drake, 81
Dallas, Texas, Sept. 13, 2016
- John Humston
Beeville, Texas, Oct. 5, 2016
- Marie Gramann, 103
Brownwood, Texas, Oct. 19, 2016
- Dennis Gustafson, 69
Las Vegas, Nev., Sept. 18, 2016
- Joseph Mueller, 90
Corpus Christi, Texas, July 11, 2016

Editor's note: "In Memory" listings are based on information received from the AAPG membership department. Age at time of death, when known, is listed. When the member's date of death is unavailable, the person's membership classification and anniversary date are listed.)

The Geologic Aspects and Future of Nuclear Waste Disposal

By MADELINE ATKINS, AAPG/AGI Intern

Waste is a significant byproduct of many forms of energy production. The waste from nuclear energy production is especially hazardous due to its radioactivity, which has the potential to cause harm to both human and environmental health. As spent nuclear fuel accumulates at commercial reactor sites around the country, the United States is in desperate need of a long-term solution for nuclear waste disposal.

Nuclear waste is typically in the form of highly-radioactive uranium and requires carefully planned disposal in order to minimize risks of exposing the environment or humans to radioactivity.

A 1956 report published by the National Academy of Sciences recommended deep geologic repositories for permanent disposal of nuclear waste. Mined geologic repositories are still considered by scientists today to be the best option for disposal and storage; however, many geologic, environmental, economic and other factors impact site location. Consequently, assessing a site for permanent nuclear waste and spent nuclear fuel is difficult, making earth scientists an invaluable resource for evaluating potential sites.

A potential nuclear waste disposal site should be determined based on its chemical, hydrological, mechanical and thermal properties, as well as human and natural disturbances. The porosity, permeability and thermal conductivity of the rock determine its ability to safely isolate high-level nuclear waste (HLW) from seeping into groundwater supplies. A rock with low porosity, low permeability and high thermal conductivity is preferable when selecting a site for disposal. Salt deposits are recommended as a good medium for disposal of radioactive waste due to the absence of water flow, the ability of salt to fill its own fractures and the ease of mining. Other factors include possible human disturbances. For example, if a repository is placed near a valuable mineral resource, this could increase the likelihood of its disturbance if mining were to occur in the future. Also, location of faults and associated seismicity, which can impact nuclear waste by both breaking and shaking the drums of waste, must also be taken into account when creating a site intended for permanent disposal.

Current Status of Waste Disposal

Within the United States, there are currently 100 licensed and operating nuclear power reactors in 35 states, the vast majority of which are east of the Rocky Mountains. In 2014, these plants produced 19.5 percent of U.S. electricity – a proportion that continues to grow annually. There are 11 new reactors under construction at various sites across the country, increasing our capacity to produce more nuclear energy in years to come, as well as producing more nuclear waste that needs disposal. Nuclear waste is classified in two general categories based on the level of radioactivity: low-level waste (LLW), such as contaminated tools and clothing from reactor operations, and the aforementioned HLW, the spent reactor fuel and nuclear defense weapons waste. Currently, nuclear defense weapon waste, such as materials used to produce nuclear weapons during the Cold War, is disposed of in New Mexico's Waste Isolation Pilot Plant (WIPP). However, with the exception of WIPP, there is currently no repository for



The Diablo Canyon Nuclear Power Plant is located near Avila Beach, Calif. Courtesy of Pacific Gas and Electric.

the permanent disposal of HLW and LLW.

Today, a reactor's spent nuclear fuel is stored on-site at the originating reactor. A 2014 Government Accountability Office (GAO) report found that the United States produces 2,200 metric tons of spent nuclear fuel annually, adding to the 70,000 metric tons of nuclear waste already in temporary storage on reactor sites. Once spent, the high-level uranium waste is cooled in a large pool of water for a minimum of five years, where it loses most of its radioactivity. When these pools reach capacity, the spent fuel is removed and transported to a dry storage module, which is an expensive and time-consuming process. Annual operations for each of these on-site storage facilities can cost between \$100,000 and \$6.5 million, depending on the reactor's operational level. The GAO estimates that these on-site storage facilities will contain 139,000 metric tons of nuclear waste by 2067.

Federal Agencies and Current Legislation

The U.S. Department of Energy (DOE) Offices of Environmental Management (EM) and Nuclear Energy (NE) and the Nuclear Regulatory Commission (NRC) Office of Nuclear Material Safety and Safeguards (NMSS) are the main federal agencies involved with nuclear waste disposal. The Environmental Protection Agency (EPA) and state governments are also involved in certain aspects of creating long-term storage sites.

The Nuclear Waste Policy Act of 1982

(NWPAA) is the main piece of legislation governing the disposal of HLW. NWPAA specified a process for evaluating repository sites, created a Nuclear Waste Fund, and included an outline for interaction between state and federal governments. The Act also required DOE to develop, build and operate a geologic repository; EPA to create environmental standards; and NRC to license DOE to operate the repository within EPA's standards.

A 1986 amendment to NWPAA designated Yucca Mountain in Nevada as the future site of all U.S. commercial nuclear waste, and was granted congressional and presidential approval in 2002. Following this approval and after evaluation of the site, DOE submitted a license application to NRC in 2008 to begin development. However, DOE withdrew its application in 2010, and federal funding for creation of the repository was halted by the Obama administration in 2011 under the Department of Defense Continuing Appropriations Act.

Following the decision to suspend Yucca Mountain as a potential repository, the GAO performed a study to determine the reasons for and effects of termination. Although DOE claims that the Yucca Mountain repository program was terminated because better solutions exist, the GAO report highlighted social and political opposition to the repository as the key issues with creating a permanent disposal site, not technical or geologic conditions. The report also recommended



The underground exploratory studies facility is located at Yucca Mountain in Nevada. It was built by the Department of Energy to determine if the location was suitable as a deep geological nuclear waste repository. Courtesy of the Department of Energy.

more transparency, economic incentives and public education on nuclear waste, as well as consistent funding, policy and leadership on nuclear waste disposal in order for a comprehensive national plan to be established.

The Future of Domestic Nuclear Energy

In 2010, DOE created the Blue Ribbon Commission (BRC) on America's Nuclear Future to help identify alternatives to Yucca Mountain. The BRC was required to provide information for the future of HLW disposal, and produced a report in January of 2012. In coordination with DOE, BRC created a timeline to create a pilot interim storage facility by 2021, a full-scale interim storage facility by 2025 and a permanent storage facility by 2048.

The government is examining other types of disposal, such as deep borehole (DBH) disposal, which involves drilling 5,000-meter deep holes into crystalline rock, placing canisters of waste at the bottom of each hole and sealing off the top. The main difference between DBH disposal and repository disposal is distribution of waste. A repository would be at one central location whereas drillholes can be distributed around the nation. In January 2016, DOE selected a team to drill a test borehole near Rugby, N.D.. However, the DOE announcement has been met with pushback from the local government. Currently, the Pierce County Commission, within the jurisdiction of which DBH tests would be administered, has sent a letter to the University of North Dakota Energy And Environmental Research Center asking that the project be abandoned. DOE has not yet released a response to the letter.

When considering the future of U.S. nuclear waste disposal, it may be beneficial to look toward other countries' disposal methods. Finland is progressing to become the world's first country to open a permanent repository for HLW. At the Onkalo site, a 420-meter-deep access tunnel in Eurajoki, Finland has already been excavated to reach a granite repository that is set to open in 2020 and have the capacity to receive spent nuclear fuel for at least 100 years. A U.S. Geological Survey study finds that shale formations are another option for disposal; studies in France, Belgium and Switzerland also indicate that shales and other mudrocks may be provide suitable sites for repositories.

The future of nuclear waste disposal in the United States has an uncertain path forward. In order to move the current 70,000 metric tons of spent nuclear fuel from reactors across the nation to a permanent storage facility, a comprehensive action plan is needed that includes coordination across the public, private and academic sectors. However, basic research for nuclear waste disposal options can only go so far, because once a site has been chosen, the local geology will dictate the scientific assessment of repository safety and capability. And, given the social and political recommendations provided in the 2011 GAO report, as well as an outdated NWPAA, there is still a need for a complete congressional overhaul of nuclear waste policy and public awareness in order to successfully create a permanent storage solution for nuclear waste in the United States. ■

Meeting Rising Oil Demand with New Thinking

By DAVID CURTISS

Shell made headlines last month when, on a conference call with investment analysts, its Chief Financial Officer Simon Henry said, "We've long been of the opinion that demand will peak before supply. And that peak may be somewhere between five and 15 years hence, and it will be driven by efficiency and substitution, more than offsetting the new demand for transport."

I read that quote in a Nov. 2 news article on Bloomberg.com, which went on to read that this forecast put Shell at odds with Exxon and Saudi Aramco, as well as the World Energy Council, which all see demand growing through 2030 to 2040 and beyond.

The casual reader of stories like this might believe the end of oil is upon us and that within the next one or two decades, the oil chapter of our energy story will be written and come to a close. But, in fact, these forecasts are about how much *demand* for oil will *grow*. And when demand peaks, it doesn't then fall to zero.

Peter Tertzakian picked up that idea in his Nov. 10 column in the Financial Post. He wrote, "recent data suggests that the world will soon touch a milestone rate of oil consumption: 100 million barrels every day." He thinks that will occur in 2018.

Tertzakian, chief energy economist and managing director of Calgary-based ARC Financial Corp., was the all-convention luncheon speaker at our Annual Convention and Exhibition earlier this year in Calgary and wrote a book in 2006 entitled, "A Thousand Barrels a Second," talking about the implications of global oil consumption exceeding 86.4 million barrels of oil per day.

"There is a lot of popular talk about using



CURTISS

Consider how much oil must be found and produced simply to maintain a demand growth rate of zero percent. And who is going to do it?

less oil, the end of oil, and other headline-grabbing projections of imminent demise," he continued. "But oil is a stubborn tree-climbing animal. Just when you think that you've trapped it from rising higher, it gets away on you and keeps climbing."

Eventually demand will flatten and peak. But consider how much oil must be found and produced simply to maintain a demand growth rate of zero percent. And who is going to do it?

Tomorrow's Oil Industry

One feature of this downturn is that the long-heralded "crew change" is upon us within the majors and large independents. And this shift, combined with technological and political challenges we face in producing the oil and natural gas the world demands, will require new thinking about how oil and gas companies operate.

In September of this year, the consultancy McKinsey & Company published an article entitled, "The oil and gas organization of the future," available on its website. In the article, they identify three trends that are disrupting our industry:

► Resource abundance is reshaping the energy landscape, driving prices down and putting pressure on the historic centralized business model that most oil and gas companies have adopted. They point out that different resource types actually require different operating structures to succeed – the model needed to exploit a deepwater discovery is not what you need to efficiently manage a resource play.

► The use of data, analytics, machine learning and (possibly) artificial intelligence is what enables operators to boost efficiencies in this low price environment. They see greater numbers of knowledge workers being displaced by these technologies, and the skills demand shifting to those who can manage this interplay between data and interpretation.

► Demographics will drive the oil and natural gas company of the future and millennials will make their marks on the industry, both with their natural facility with data and technology and their characteristic desire to not simply have a job, but to actually pursue meaningful work that doesn't merely deliver a paycheck.

The authors of the article identify five "big

ideas" that will drive companies in the future:

1. Organizational agility – creating a responsive and flexible company
2. Digital organization – positioning to make use of the flood of data available as the "Internet of Things" expands
3. The millennial-managed organization – this generation's needs and desires will affect how companies behave and operate
4. The decentralized company – structuring firms to match the targets they're pursuing, with varying degrees of centralization and distributed decision-making
5. A redefinition of what's core – understanding at a deep level what the organization's strategic advantage is and leveraging that

Have they gotten this right?

I have no idea, but the entire article does make for interesting reading and stimulated my thinking about how the petroleum industry and our profession as petroleum geoscientists may evolve in the coming decades, because it will surely change.

It's been a tumultuous year by any measure. But as we leave 2016 behind and as AAPG prepares to celebrate its 100th anniversary in 2017, we're looking forward and envisioning how we can better meet the energy needs of a growing world.

DIVISIONS REPORT: DEG

A Tale of Four Cities

By TIMOTHY MURIN, DEG President

From mid-September through mid-October, I had the unique opportunity to represent the Division of Environmental Geosciences at four events, and want to share some of the highlights with you. The cities included Washington, D.C.; Lexington, Ky.; Las Vegas and Houston.

Eastern Section Meeting

The Eastern Section Meeting was held in Lexington, the "Heart of the Bluegrass State." Several of the technical sessions covered the Marcellus and Utica Shale plays in the Appalachian Basin, structural effects on reservoirs and groundwater and environmental issues. Co-Chairs Dave Harris and Rick Bowersox did a great job, and attendance was good.

I also heard the special event with bourbon sampling and palate-cleansing munchies was a hit. James McGhay chaired the House of Delegates meeting where there was a lot of discussion about issues that need to be addressed going forward.

In particular, we (AAPG and each of the Divisions) need to determine "What do we offer to our Members?" and "How do we attract new Members?"

Rocky Mountain/Pacific Meeting

Next was Las Vegas. Not much has changed since my first trip in 1976 on



MURIN

We need to do whatever it takes to keep AAPG alive and well for the next 100 years.

the way to field camp. This was a joint meeting of the Pacific and Rocky Mountain sections. The meeting was held at the Paris Hotel, which is distinguished by an impressive replica of the Eiffel Tower.

I was intrigued by several of the presentations on geothermal resources. The western United States is where activity is happening in this field, unlike the eastern states, with their relatively cooler rocks.

I was finally able to meet some DEG Executive Committee and Advisory Board members. Namely, President-Elect Stephen Testa and Allen Waggoner of the Pacific Section. Please congratulate Allen on being awarded the Pacific Section's highest honor, Honorary Life Membership, for outstanding service and devotion to the science and profession of petroleum geology.

A luncheon was held where I spoke on behalf of the DEG, along with Division of Professional Affairs President Chandler Wilhelm and Economic Minerals Division President Anne Draucker.

Congressional Visits Day

Congressional Visits Day was held recently in Washington, D.C. It was a gathering of about 40 geoscientists from industry, government agencies and academia. The primary goal was to meet with members of the Senate and House and raise awareness among policymakers about issues affecting the geoscience industry and education.

This was my first time to get an insider's perspective of "The Hill." Our group was probably one of 100 or more groups meeting with congressional staff for the day, which made it a very busy place.

Edith Allison attended, and has been representing AAPG as the director of the Geoscience and Energy Policy Office with the purpose of educating government officials and helping them to rely on science as a basis for policy decisions. I certainly appreciated her help in navigating through the buildings and streets. Also, thanks to Peter MacKenzie for having us as his guests at the Army and Navy Club. During dinner, it was a pleasure to talk with AAPG's President Paul Britt and Executive Director David Curtiss about the current status of AAPG.

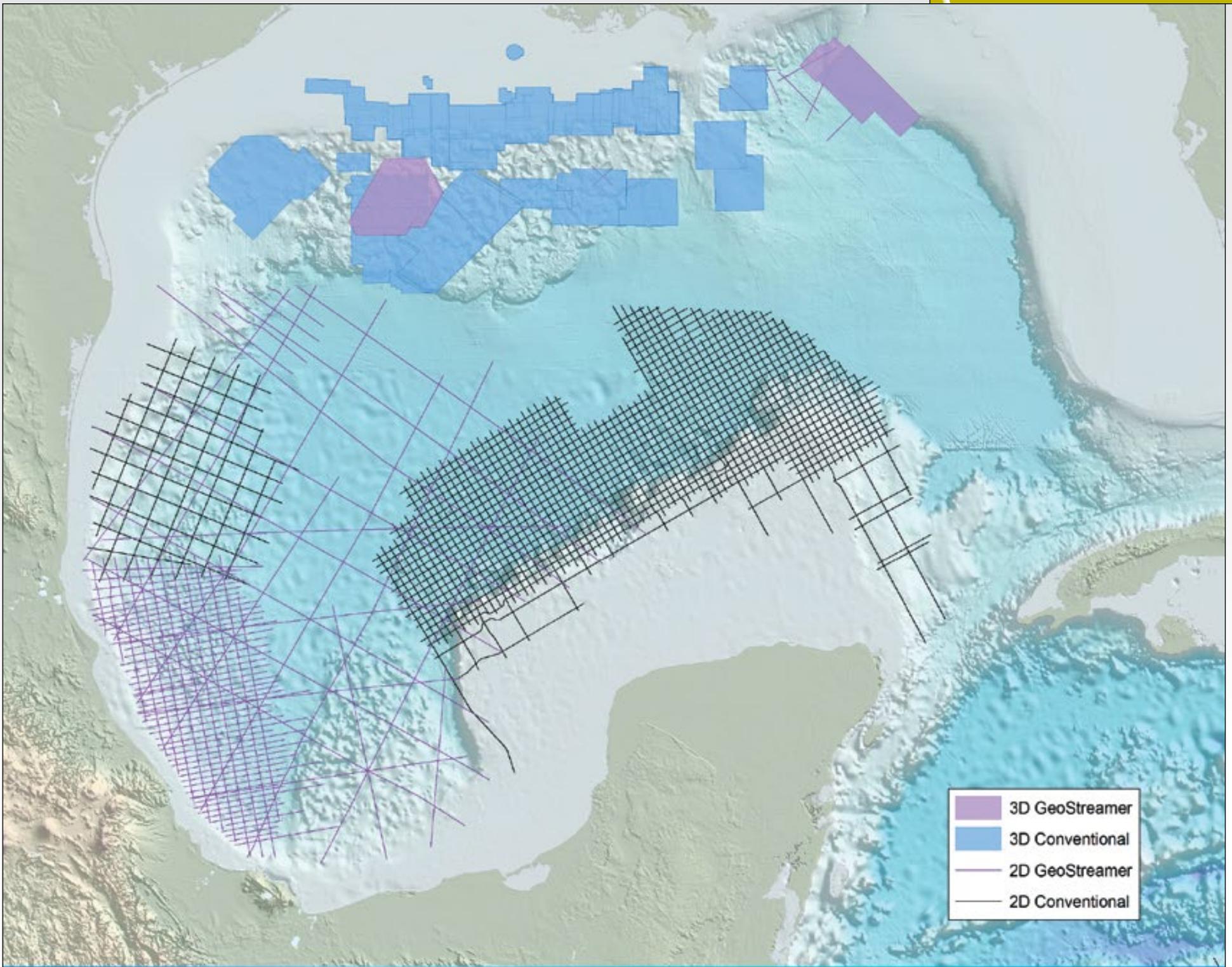
Mid-year Meeting

AAPG's Mid-Year Business meetings were held in Houston. The three days of the meetings were extremely busy, and it was attended by the Association's Executive Committee and Advisory Council Members, which include the presidents of the Divisions, Sections and Regions. Advisory Council Chair John Hogg did an outstanding job of keeping the meeting on topic and on time.

The two main areas of focus were reviewing and selecting recipients for honors and awards that will be presented at the 2017 100th Anniversary ACE (see the article announcing the winners on page 6), also in Houston, and the current challenges facing AAPG and proposals for meeting them.

It should come as no surprise that membership and attendance at meetings are down. Fewer exhibitors – the primary source of income for the organization – has a major impact on AAPG's budget.

Unfortunately, AAPG lost money last year. Much discussion ensued, scrutinizing essentially everything that AAPG provides to its Members. Clearly, some elements, like the method of accounting for the Divisions, can be changed to cut losses. New Members, especially Students and Young Professionals, need to be approached since they will become the future leaders of the organization. We need to do whatever it takes to keep AAPG alive and well for the next 100 years.



Gulf of Mexico HOTSPOTS

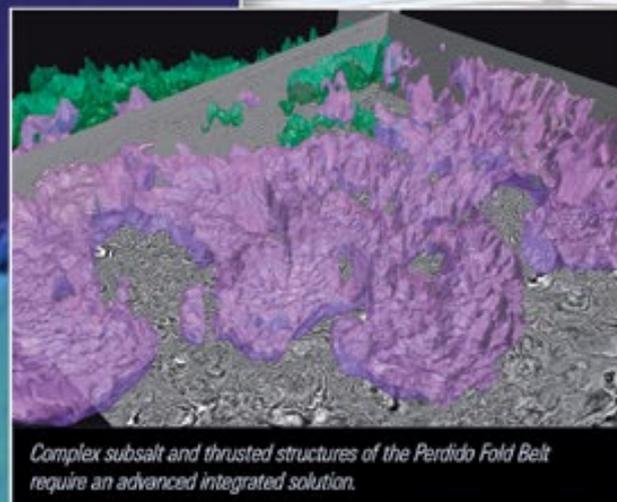
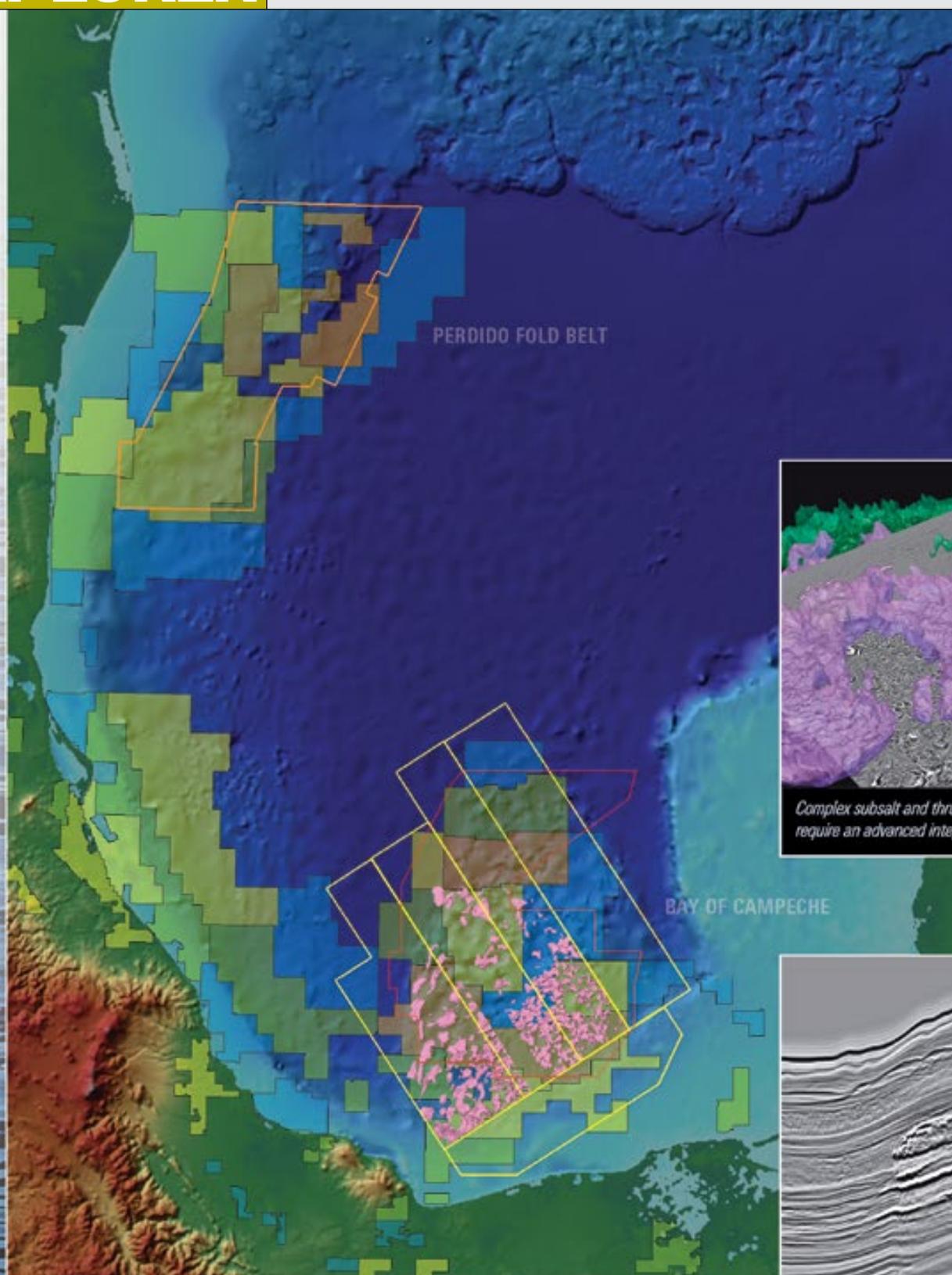
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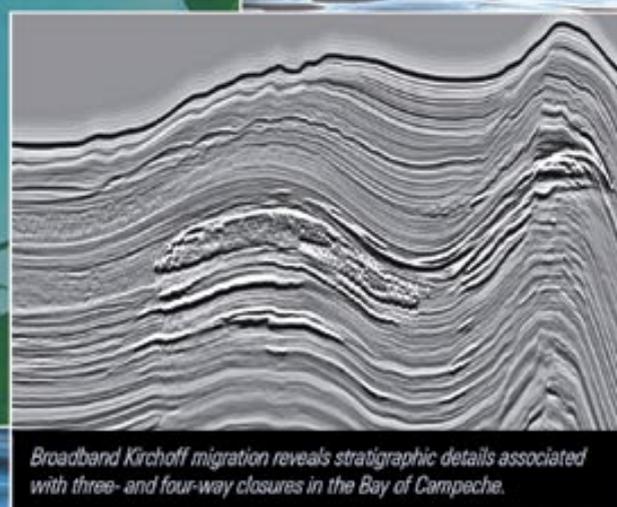
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