AAPG EXPLORER

MARCH 2015

Hold On!

Past trends suggest "hanging in there" is STILL a good idea

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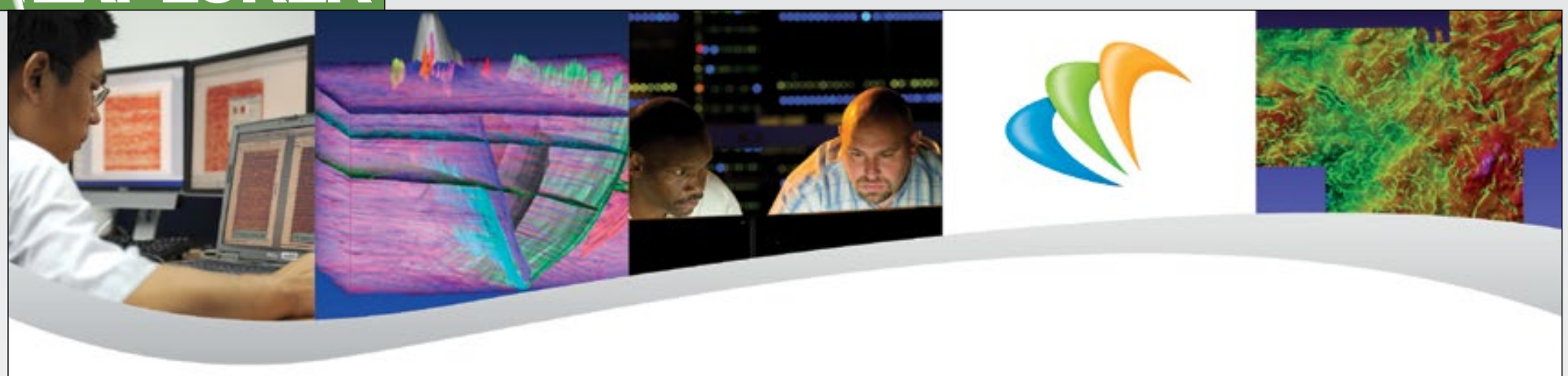

Vol. 36, No. 3
March 2015

AAPG EXPLORER

PRESIDENT'S COLUMN

Doing what we do better ...

In Between Booms? AAPG Can Help

By RANDI MARTINSEN


MARTINSEN

Being part of our AAPG community is even more important during downturns than when things are flying high.

Well, we all knew it would happen … sometime.

Our industry has *always* had ups and downs, and now we are back in one of the downs with a 60 percent drop in the price of oil from the price high of last June.

Everywhere I go people ask me, why has the price of oil dropped, and when will it recover?

I only know what the talking heads tell me about why it is down and my crystal ball is in the shop for repair, so I don't know when it will recover, but, like you, I hope that the recovery begins in the not-too-distant future.

* * *

Every downturn for me turns my thoughts to the downturn of 1986. That was the first one I experienced, and, wow, that was a bad one.

I, along with many others, was hired during the mega boom of the early 1970s and knew nothing but high oil prices and high-flying times for the first 12 years of my career.

Then came 1986, and everything changed.

Most of us who endured that one surely remember the then-popular bumper sticker: *"Please God, just give me one more oil boom. I promise not to p#!% it away next time."*

So many of my colleagues lost their jobs, changed their careers. My consulting business dried up and I found I had lots of time on my hands.

Fortunately for me, I also had a position as lecturer in petroleum geology for the University of Wyoming. It was only a part-time position at that time, but it was a position and it provided some income.

I had a little income, and a fair amount of time – so what did I do?

I got ready for the future by attending conferences and short courses (mostly AAPG offerings, but those of my local societies as well – RMAG, WGA, RMS-SEPM), and by being more active in AAPG, and thus expanding my network.

I also worked on projects that had been on the back burner because of lack of time but that I thought had potential, and that interested me.

Interestingly, these things made me more attractive to the university, and they expanded my position to include teaching more courses, supervising graduate students and doing research. Although an academic career had never been part of my plan, I found I enjoyed teaching and tried very hard to emulate the role models who so inspired me when I was a student.

Although I was no longer drilling wells, I was still engaged in studying and trying to better understand the petroleum systems of the Rocky Mountains.

Yes, I was very lucky – but I also had worked hard from the time I first went to work, and with the support of my company and my bosses:

- I had been active in AAPG and SEPM and my local societies.
- I had published and given presentations.
- I had led field trips.
- I had taught short courses.

Although I didn't realize it at the time, I was building my career and my network along with my knowledge and my technical and soft skills. My love of geology and the warm receptions and strong support I felt from my colleagues at professional meetings, as well as the support of my colleagues at work and my company, simply led me to do these things.

It wasn't until later, when conditions in the industry started improving, that I realized just how important my various professional activities were.

* * *

The message for today is clear:

Companies, while tightening their belts and evaluating how best to spend their efforts during this downturn, should also be looking at the long term and how to best position themselves for the next boom.

Geoscientists should be doing the same.

Being part of our AAPG community is even more important during downturns than when things are flying high.

AAPG has:

- The technical information and educational opportunities you need to stay up-to-date.
- Conferences to keep you informed while providing ideal venues for maintaining old and making new personal contacts.
- An AAPG global community that could very well lead to your next opportunity.

AAPG can help you continue to build your career – and provide opportunities that allow you to showcase your talents.

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REGULAR DEPARTMENTS

Scan this for the mobile version of the current web Explorer.

ON THE COVER:

This month's EXPLORER is our annual Seismic Advances issue, featuring several stories that cover the latest in technological and industry trends. But it also features something else: An awareness by most of our sources that the industry's "current economic climate" is what most people want to discuss. And that brings us to the theme of our cover – a dramatic photo of a rock climber, captured by Adam Kubalica, holding on while stilll managing to advance. And that's a message that we heard a lot this month. Stories to follow.

Left, AAPG member Gil Mull on Alaska's Mt. Doonerak in the 1980s – he also has a story to tell about creatively surviving tough economic times. See story on page 22.

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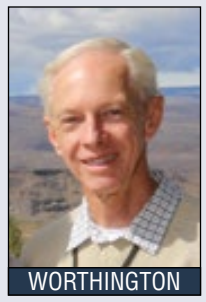
David Worthington Wins AAPG Foundation's Highest Honor

David Worthington, a significant contributor to the AAPG Foundation and an officer and leader of both the Foundation and the Trustee Associates, has been named the recipient of this year's L. Austin Weeks Memorial Medal.

The award, given in recognition of extraordinary philanthropy and service in advancing the mission of the AAPG Foundation, is the Foundation's highest honor.

Worthington will receive the award during the opening session of the AAPG Annual Convention and Exhibition, which will be held May 31-June 3 in Denver.

Worthington, the former CEO of TGS-Calibre and chairman of TGS-NOPEC, and his wife, Beverly, now reside in Naples, Fla.


WORTHINGTON

A Foundation Trustee Associate since 2001, Worthington has been both vice chairman and secretary-treasurer for the group, as well as chair of the 2014 Trustee Associates Site Selection Committee.

He has served as a member of the AAPG Foundation's Member of the Corporation since 2013.

He and his wife, Beverly, also have established two named grants with the Foundation's Grants-in-Aid program – the David W. Worthington Named Grant and the David W. Worthington Family Named Grant, both created and awarded annually to deserving graduate students studying paleontology.

A native of Worcester, Mass., Worthington received a bachelor's degree in geology from Marietta College in Marietta, Ohio, and a master's degree in geophysics from Virginia Tech University.

He began his career with a 12-year stint at Shell Oil, eventually becoming exploration manager of Shell's Gulf of Mexico and Atlantic Division. He left Shell to form his own offshore exploration firm, which transitioned into TGS Geophysical Co.

That company later became TGS-Calibre and, through a merger, TGS-NOPEC, where Worthington served as chairman from 1999-2004, remaining on the board through June 2007.

The L. Austin Weeks Memorial Medal was established in 2008, and Worthington is the award's eighth recipient. Others have been:

- 2008 – Marta Weeks
- 2009 – T. Boone Pickens
- 2010 – Larry Funkhouser
- 2011 – Jack C. Threet
- 2012 – William J. "Bill" Barrett
- 2013 – Robert "Bob" Gunn
- 2014 – James A. Hartman

Candidate Bio Videos Debut In March

Short videos created to introduce AAPG officer candidates for the 2015-16 term to the membership will be available on the AAPG website in March.

The newly created "bio briefs," produced by AAPG specifically for the upcoming election, will be followed in April by videos that allow all candidates to present themselves and express their views and opinions on various topics involving the membership in a concise question-answer format.

Online voting is scheduled to begin March 31.

The person voted president-elect will serve in that capacity for one year and will be AAPG president for 2016-17. The terms for vice president-Regions and secretary are two years.

Biographies and responses from all candidates were included in the February EXPLORER and are available online.

The slate is:

President-Elect

❒ Paul W. Britt, Texplore Inc., Houston.

❒ Gretchen M. Gillis, Aramco Services Co., Houston.

Vice President-Regions

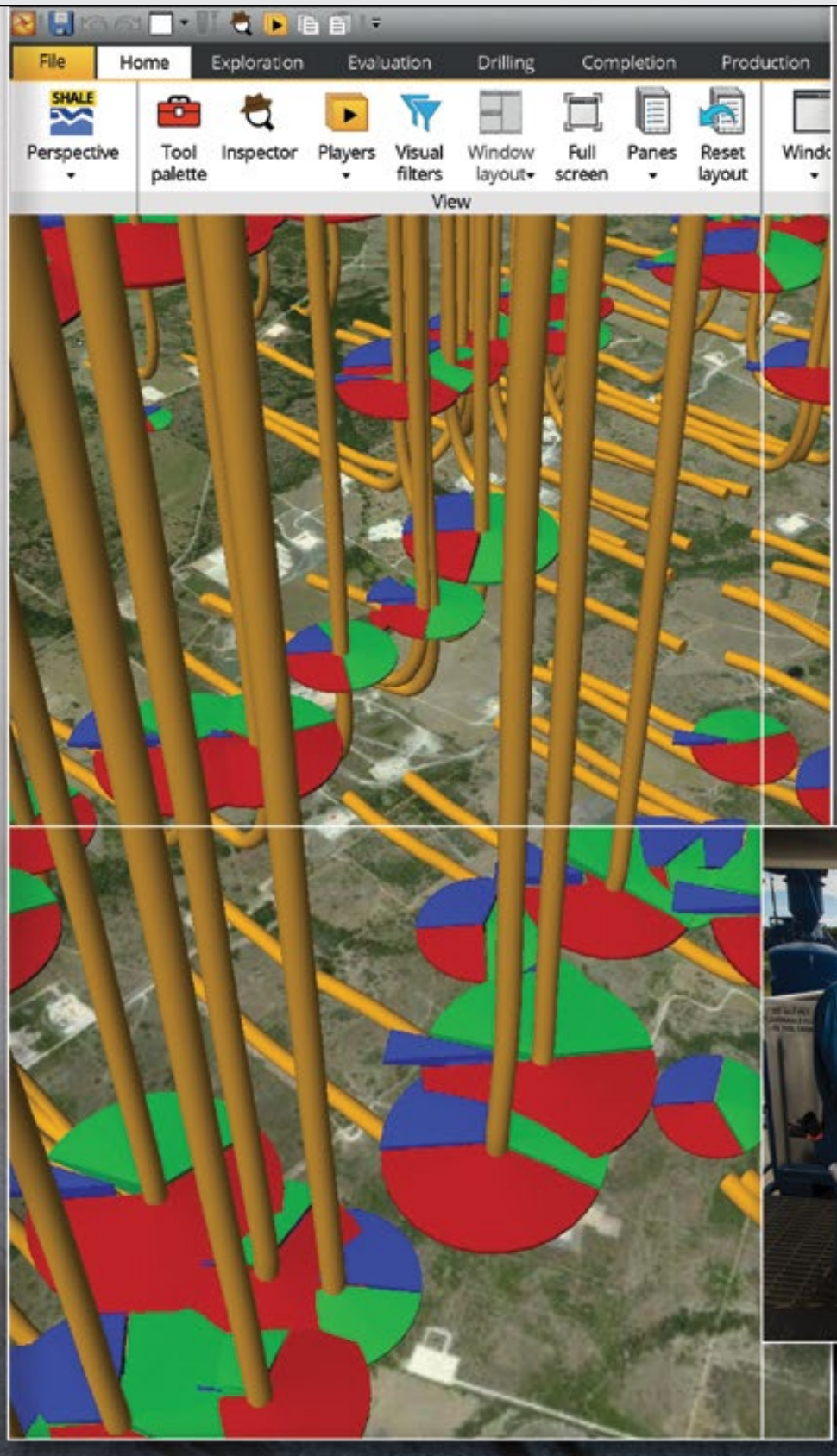
❒ Adebayo O. Akinpelu, Fixital Ltd., Lagos, Nigeria.

❒ Peter M. Lloyd, Asia Pacific Training Ltd., Falicon, France.

Secretary

❒ Heather L. LaReau, Noble Energy Inc., Denver.

❒ Nicole S. Morris, Atlas Resource Partners, L.P., Fort Worth.



Oil price impact

Downturn Offers Opportunity to Reprocess Seismic

By HEATHER SAUCIER, EXPLORER Correspondent

If operators take the "glass half full" approach and use their idle time wisely during the industry's current downturn, the seismic industry – at least parts of it – could experience an upswing.


SACREY

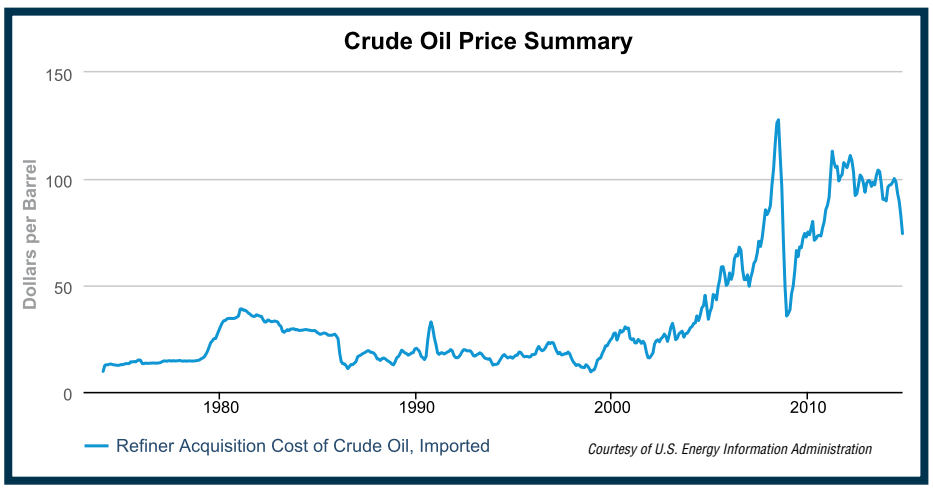
It's no secret that when oil and gas prices drop, industry players first scale back on drilling and seismic acquisition – their most costly expenditures.

It's certainly a punch in the side to the seismic industry, which has been moving full steam ahead since the shale oil and gas boom hit the United States in the early 2000s.

Major service companies such as Baker Hughes Inc. (which is being acquired by Halliburton Co.), Schlumberger Limited and Weatherford International recently announced layoffs of 7,000, 9,000 and 8,000 employees, respectively. Halliburton recently announced the elimination of 1,000 positions in Houston.

However, companies that specialize in seismic processing and seismic monitoring could see their businesses grow.

"Falling oil and gas prices is a double-edge sword. It's bad in some respects, but good in others," said past AAPG treasurer Deborah Sacrey, owner of Auburn Energy, a Houston-based geological consulting company.



"It's a bad time to drill wells and acquire additional seismic, but it's a good time to dig into the seismic data you have and reprocess it," Sacrey said. "People have been going so fast and furious to drill wells that they haven't been paying close attention to their seismic data to see if their well locations were located optimally for the best production."

Along the same lines, now also is a good time to revisit the optimization of well completions and eliminate unnecessary stages and pumping that could cost hundreds of thousands of dollars, said AAPG member Peter Duncan, co-chairman and founder of Houston-based MicroSeismic Inc.

"Reducing the cost for the wells you need to drill," he said, "that's where the focus is these days."

Wringing Seismic Data Dry

In general, onshore acquisition of seismic can cost tens of thousands of dollars per square mile – more costly compared to reprocessing data, said Mike Dunn, senior director of geophysics, geology and reservoir management for Landmark, a Halliburton business line.

"It's a good time to do reprocessing because it's a lot cheaper," he said. "If you can get more information from your existing data, why not do it?"

For example, in the Gulf of Mexico, initial velocity models were built to expedite data sales, and as a result shortcuts were often taken, Dunn said.

"You can improve your seismic data by including new well information and updating those models," he said.

In terms of its use in unconventional plays, seismic remains in infancy stages, Dunn explained. Much more information can be gleaned from seismic data with the right tools and techniques, which are constantly evolving and being brought to market.

In many cases, the application of new processing technology can open up new geologic plays, Dunn said. For example, in the deepwater Wilcox Basin in the Gulf of Mexico, a play remained unknown until the early 21st century – a time when improved processing techniques exposed large structures below the salt.

"By improving overall data quality, operators can still explore and discover plays that were not identified previously in many basins around the world," Dunn said.

If seismic data is older than five or six years, reprocessing can likely optimize well locations, Sacrey said, explaining that companies might have pieces of 3-D seismic that need to be merged or re-bended or additional seismic attributes that might need to be further scrutinized.

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Impact
from page 6

Sacrey also said she is noticing that some seismic processing companies are lowering their prices to encourage operators to reprocess their data.

"Processing technology changes so much these days," she added. "Take advantage of this ever-evolving field. Think of a towel – take your seismic data, wring it out and get all you can out of it."

Optimizing Completion Processes

For Duncan, the current downturn is like déjà-vu: "I've seen several of these cycles before, he said, "and I'm not panicking.

"I know from the service side that when times are tough, you have to hunker down, polish your product and be even more diligent about meeting your customers' needs," he added.


DUNCAN

> **"You are simply getting more life out of what already exists and it keeps your staff employed."**

Duncan is finding that when "every penny counts," some operators are focusing on making their existing well completions more effective by refrac'ing and monitoring those "refracs" as an alternative to drilling.

"It's beginning to drive my business," he said.

In a trend that began late last summer, operators have begun to rely on refracs to maintain production – a delicate process that Duncan said requires more monitoring than initial fractures.

"A lot of operators are going back in and recompleting their wells and are seeing production increasing again," he said. "It may not be back to the original volumes, but it is still significant."

With the infrastructure already in place, there is no need to drill another well.

"You are simply getting more life out of what already exists," Duncan said. "And it keeps your staff employed."

Whether a well is being completed for the first time or is undergoing a refrac, real-time fracture monitoring can help detect mechanical and geological failures that are often caused by faults that become reactivated when a rock is hydraulically fractured. The faults become "thieves," Duncan explained, by soaking up fluid and proppant over several fracturing stages.

When detected through monitoring, faults can be sealed and grouted off to promote the fracturing of new rocks.

In recent refrac projects, Duncan has found that diverters often fail, and most of the frac energy is concentrated near the heel of the well. Microseismic monitoring helps operators quickly diagnose this problem and find a solution.

Furthermore, real-time monitoring can curtail the pumping process, saving both time and proppant loss. When the surface area of a frac is no longer increasing, shutting down pumping during the "lazy stages" can provide a cost savings ranging from $20,000 to $50,000 per hour, Duncan said.

Monitoring also can help reduce the number of stages in a hydraulic fracturing operation by detecting overlapping stages that could be spaced out, Duncan said. Eliminating a stage can save operators anywhere from $100,000 to $400,000.

On the other hand, an additional stage might be needed to recover more hydrocarbons.

If wellbore spacing is an issue, monitoring can determine if the distance between wells is sufficient.

"Make sure you are not spending too much to harvest the most hydrocarbons from your field," Duncan said. "You don't want overlapping drainage areas in your well."

Gas in the Interim?

While current oil and gas prices are allowing operators to take what could be a productive pause, too much downtime has some fearing a repeat of the 1980s oil glut.

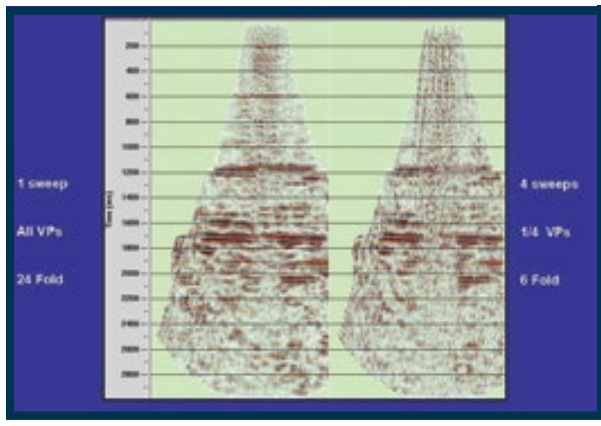
"There seems to be an attitude difference between the larger companies and the smaller companies," Sacrey noted. "The larger companies have the cash base to retrench and wait this out. They have time to take a second look at their data and completions."

It is the small and mid-sized companies – namely those who hopped on board the shale boom locomotive and have driven it to present day – who can't take too much time out.

"Those who got into shale late or who are underfunded are most at risk," Sacrey said. "They don't have time to go back and take a new look at their seismic data."

With oil and gas prices currently at a disconnect, Sacrey speculates that some operators might shift their focus to gas, especially as the U.S. regulatory agencies continue to approve the construction of facilities – such as those in Oregon, Louisiana, Texas and Florida – for the exportation of liquefied natural gas (LNG) to counties that don't have free-trade agreements with the United States.

"That's the beauty of the industry in the United States. It's diversified," she said. "There are niches. One niche may be hurting while others are flourishing."



Redistributed sweep effort can be highly effective in attaining the goal to acquire the ideal survey.

Getting better data

Seismic: Moving Forward

BY LOUISE S. DURHAM, EXPLORER Correspondent

Like much of the technology used in the oil and gas industry, advances in the geophysical realm have evolved somewhat sporadically, yet with great impact overall.

For instance, recording consistently good seismic data today is not only possible, it's expected.

"Certainly we can get better data than in the past," noted Stuart Wright, vice president of applied geophysics at Dawson Geophysical.

"People feel like the data now is as good as it's going to be," he said. "But in my opinion we can keep getting better data, and there's a simple formula to do so.

"However, it usually costs more."

Working as a design geophysicist, Wright has an up-to-the-minute perspective on what is needed to move forward in seismic design and acquisition.

"Changes in the way we think about our surveys, design our surveys and changes in the equipment are lowering the economic barriers," he said. "We're able to get better data that doesn't necessarily cost a lot more than in the past because of advances in the equipment and the way we utilize that equipment and think about it.

"Designs of the future will utilize multi-component phones to acquire smaller bins, higher fold, better offset distribution, wide-azimuth, more bandwidth and larger areal extent.

"Designing a survey that meets these goals," Wright said, "is relatively straightforward."

3-D Seismic, Then and Now

Wright noted that the earliest 3-D survey he is aware of was acquired as a group shoot in Lea County, New Mexico, in 1972.

Chevron acquired its first 3-D over the giant Bay Marchand Field in the Gulf of Mexico in 1987. Then the company reacquired a modern wide-azimuth (WAZ) 3-D survey there in 2011, which was chosen to provide improved noise reduction, higher illumination and enhance surface coverage, according to Wright.

"Advances in equipment and design enabled Chevron to capture a better, more complete data volume," he emphasized.

"Even in the 1980s, we had a pretty good idea of what constitutes the 'ultimate' 3-D survey design," he said. "It's a 'full-fold' survey, meaning the source line interval is the same as the receiver interval, and the receiver line interval matches the source interval."

There's more to the story, though.

Consider, for instance, that long offsets are needed in every direction, along with closely-spaced sources and receivers, sufficient aperture and multi-component sensors.

And then, *voila*.

You have the makings of a great 3-D survey.

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Toward an Ultimate Design

Even so, Wright said we are moving in the direction of acquiring the "ultimate" design.

For example, he mentioned current day recording devices, such as modern nodal systems, where the only limit to the number of live channels is the amount of equipment available.

WRIGHT

"From the equipment perspective, it's all this cableless equipment, the ease of deployment, and smaller lighter-weight stuff we can put out more readily," he said. "If we had to use the big, old geophones and deploy thousands of them on a crew like now, it would take truckloads."

Redistributed sweep effort can be highly effective in attaining the goal to acquire the ideal survey.

"We can dramatically increase fold and improve offset distribution by distributing redundant sweeps to new locations yet still maintain the same 'sweep density' or sweeps per square mile," Wright noted. "The sweep density isn't changing, just the distribution of the sweep effort."

He explained that the redistribution of energy in this manner allows the geoscientists to advance more closely to the "ultimate" 3-D, yet with a relatively minor cost increase.

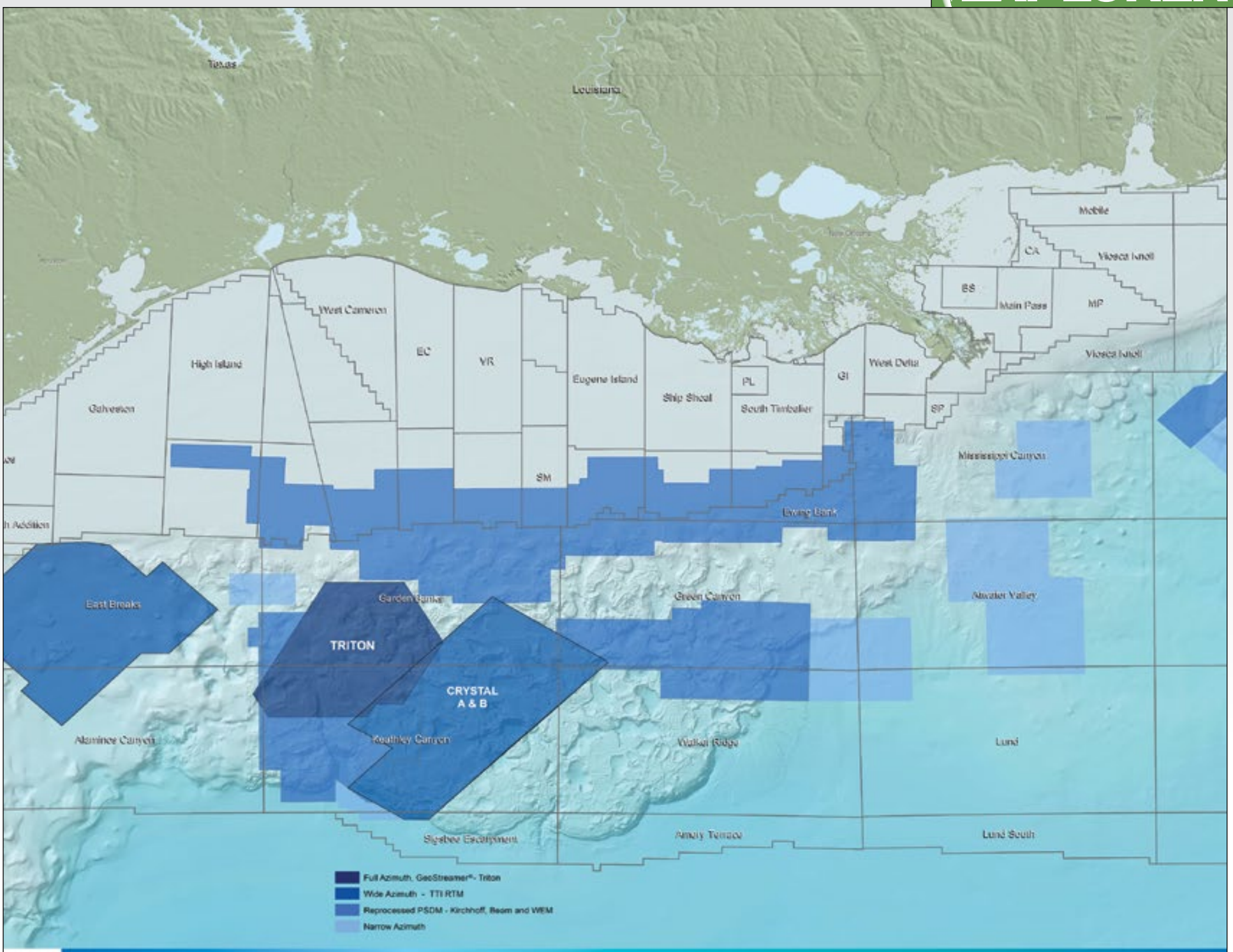
Among additional sweep adjustments, there's the promise of simultaneous sweeping, which would enable increased vibrator productivity via multiple units on multiple source locations sweeping all-out and all together.

For now, there are hurdles to overcome, like adequate separation of the sweeps, so don't plan on applying this just yet.

Wright noted that advances in bandwidth are occurring and that changes in the receiver realm mirror those for sources.

His take on acquiring better data overall is clear-cut.

"The path to better data," he commented, "is integrating the right equipment with the right concepts into the best design."



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3-D Seismic Symposium

Oil Prices, Other Factors Affecting Seismic

By DIANE FREEMAN, EXPLORER Correspondent

It's plain enough that the drop in oil prices is the leading factor impacting 3-D seismic exploration in the American West, but the extent of that impact might not be so well known.

"It overpowers and affects every decision," AAPG Honorary member R. Randy Ray recently told the EXPLORER.

"When revenue just got cut in half and nobody's spending any money, you can't do any planning," he continued. "I hope we'll start a recovery in mid-year as the price comes up to between $50 to $60 a barrel.

RAY

> **"The drop in oil prices to one-half of what it was four months ago has really changed our world in geophysics and geology."**

"My sense is that everybody is still waiting to see what happens to the oil price," he said. "What you want to know is that it has hit bottom and won't go any lower. It needs to stay in a stable price range for a month or two months.

"Then if it starts moving up gradually, everyone can look ahead and begin planning more activity," he added.

Ray was the kickoff speaker at the annual 3-D Seismic Symposium in Denver last month.

One of the founders of the 21-year conference, Ray is the president of Denver-based R3 Exploration and has specialized in the interpretation of geophysical and geological data for petroleum exploration.

"The drop in oil prices to one-half of what it was four months ago has really changed our world in geophysics and geology," he said. "It's going to cause all of us to be more cost-conscious and to work more cost-effectively."

Lost in Translation

The state of the seismic industry is influenced by more than just the price of oil, though. A second dynamic affecting 3-D seismic exploration currently is the poor communication between disciplines in the energy industry.

Ray said 3-D seismic is one of the most powerful sources of information for both exploration and resource play development.

"The 3-D seismic image is the geological context, the starting point from which you can pull geologist, geophysicist and drilling engineers together," he said.

He pointed out, however, that geophysicists tend to talk about 3-D seismic and expect engineers and geologists to fully understand what it is.

"They know conceptually what it is," he said, but they often don't realize the subsurface image helps envelope and integrate their own work.

"I think we should call it an 'earth scan' for horizontal surgery," he said. "Would you go into surgery without first getting a CT scan? Then why drill a two-mile horizontal well underground without an earth scan to guide it?

"The problem is these disciplines get caught up in technical translation," he added, "and sometimes the significance of the 3-D information is not completely communicated."

New Tools

A third dynamic impacting seismic exploration is the use of microseismic data – acquiring seismic around the horizontal wellbores by setting up a recording system to capture microseismic events when wells are fractured.

"It's one of the fastest growing seismic tools," Ray said.

Although geophysicists are using it, they're often not integrating this valuable data with the 3-D seismic that surrounds it.

"This is a huge pitfall," he warned.

"We need to put this data together," he added. "Let's have a conversation amongst the disciplines that integrates all the information."

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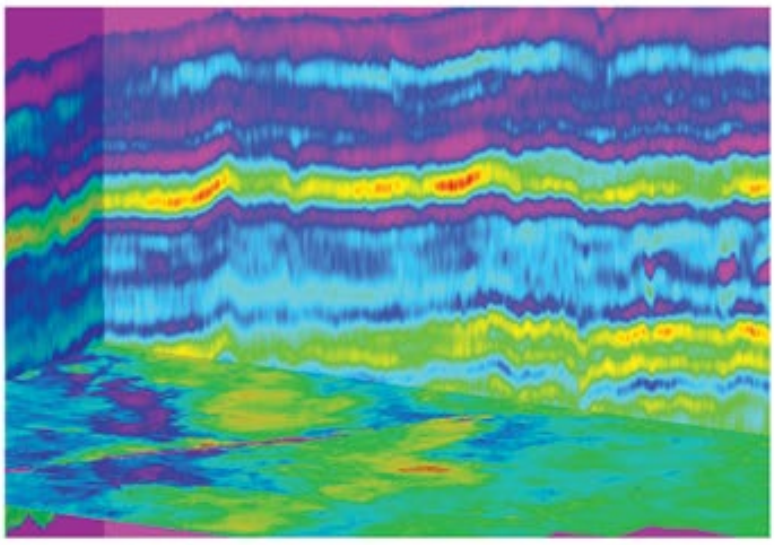
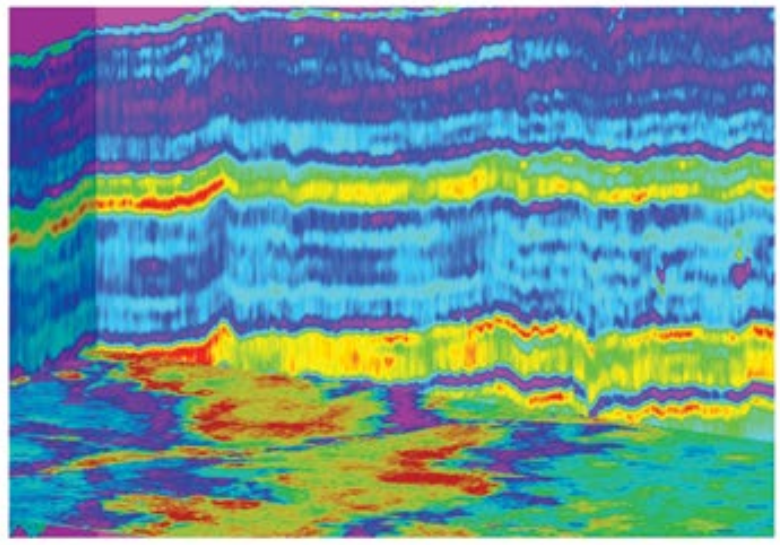


Shear impedance inversion using a commercial seismic inversion solution.



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Geomechanics – New Opportunities for Seismic

By HEATHER SAUCIER, EXPLORER Correspondent

Downturns in the oil and gas industry are rarely embraced by its players – but timeouts can sometimes be advantageous.

"When the industry slows down, we have the opportunity to catch our breath and think about how we can improve for the future," said Tom Bratton, a professor at the Colorado School of Mines who spoke at the 21st Annual 3-D Seismic Symposium on Feb. 5 in Denver. "When we as an industry come back, we want to come back smarter."

Bratton, who teaches petroleum engineering while working on his doctorate degree in geophysics, spoke about optimizing production from unconventional wells by overhauling current seismic models.

"Our models are often incorrect. They don't capture all of the variability that we observe in the data, and we make assumptions in models that violate the reality," Bratton explained.

When horizontal wells were being drilled and hydraulically fractured at break-neck pace, many operators could financially tolerate a "statistical play," in which the top 10 percent of the producing wells absorbed the cost of the remaining less productive and non-commercial wells, Bratton said.

As a result, the process of improvement was often delayed.

Now may be a good time to change that.

BRATTON

> **"Our models are often incorrect. They don't capture all of the variability that we observe in the data, and we make assumptions in models that violate the reality."**

Data First

Many operators rely heavily on offset production data to determine well locations and on current industry trends to determine the number of hydraulic fracturing stages. As a result, many choose not to log or core wells to cut costs, Bratton said.

Rather, they rely on educated guesses in developing their fields.

"When we look at unconventional wells, we find an incredible variability in their production," Bratton said. "Some wells are good but some wells are not even commercial."

To optimize results, more accurate seismic models are needed. To build more accurate models, ironically, more data is needed from cores and logs.

Decisions about where to develop in the field, the number of hydraulic fracturing stages and the rate at which to stimulate the rocks all can be made from integrated geophysical data, Bratton said.

Integrating core samples, well logs and seismic data is the first step toward building better seismic models. Cores show detailed information about a formation on a scale of one to two inches from the wellbore. They are the "magnifying glasses" in the reservoir, Bratton said. The logging scale ranges from two to five feet from the wellbore, making it the "glue" that holds core data and seismic data together, Bratton explained.

Seismic, which has a wavelength of 200 feet, covers the entire reservoir.

"To make better predictions," he said, "we need to understand all three scales.

"We are not as effective as we could be or should be in convincing the people who make the financial decisions to understand the value that geosciences can bring. Geoscientists are under the gun to reduce costs, and the engineers control the money," Bratton added. "One of my challenges is how to illustrate to the young engineers I am teaching how to become better at our craft and trade. There are so many guesses in the engineering process."

Bratton emphasized that while acquiring additional data costs more money, it leads to cost savings in the long term.

"A better understanding of the geoscience will give us more guidance in predicting how many wells we need to drill to drain a reservoir," Bratton said. "The fewer wells we need to drill, the more money we save."

Constants and Variables

When data from cores, logs and seismic is combined, a system of constants and variables is established to help determine the gaps in current models that result in wells spaced too closely or too far apart, and therefore not 100 percent efficient in draining oil along the lateral, Bratton explained.

"There are more unknowns in unconventional reservoirs than in conventional reservoirs," he said. "When you have a complex problem where you have many unknowns, the more data you have the better your chances are of solving for all of those unknowns."

Currently, a roughly 400-year-old principle called Hooke's Law is used to interpret seismic data in horizontal wells,

See **Bratton**, page 16

Economics
from page 12

Lean Times

Consolidation of seismic companies is another major factor affecting the North American seismic business.

"What's happening in the acquisition side is a real consolidation of crews that shoot seismic," he said. "It's shrinking because they're being bought out by each other."

That consolidation began before the oil price drop, he said – but the slowdown in the number of projects accelerates the movement.

For instance, there's a hold on many seismic projects because of the plunge in oil prices.

"Three-D seismic shooting is a leading indicator of future activity," Ray observed. "You plan to do that early. It can take from six months to permit and shoot new data. It typically leads drilling activity, so when budgets are being cut, 3-D seismic is the first to be affected. You plan to spend that money at the start."

By contrast, microseismic data can be recorded in adjacent wellbores and can be designed and acquired quickly as part of the well completion plan. Microseismic is more real-time data that helps the completion engineer evaluate the effectiveness of his expensive formation fracs.

But with prices down, many projects are not moving forward as they would otherwise. Planned and future planning of 3-D seismic acquisition is on hold.

"They're everywhere from not hurrying even though they've started to waiting awhile on it," Ray said.

"I think it's temporary, particularly in the western United States," he added. "Our permit cycle for 3-D is a full year, especially on any federal lands administrated by the Bureau of Land Management.

In the U.S. West – the Rockies and California – the drilling rig count has dropped precipitously.

"New drilling has stopped," he said. "Resource play drilling that already has started is going on because once you drill and frac a shale well you can't turn them off, because it will damage the ultra-tight reservoir," he said.

"In the United States," he said, "it's going to take us a year to sort this low oil price cycle out."

Bratton
from page 14

Bratton said. Hooke's Law assumes that velocities are independent of load or stress in the earth.

It is an assumption that when applied to seismic data, is often incorrect, he said.

"If Hooke's Law, when applied to seismic interpretation, were correct, no matter what magnitude of stress is applied on subsurface material, the acoustical velocity in the formation would always be the same," he explained. "But stress often affects the velocities. Hooke's Law doesn't work. It makes the wrong prediction."

While the equation works for some formations, "More terms are needed for most formations in all of these unconventional fields," he said.

A non-linear model is needed to take into account all variables, including porosity, lithology and stress, as all are changing within the formations in unconventional wells, Bratton said, adding that the industry needs to better understand the stresses in the earth and how they affect velocity. Only then can seismic data be more accurately interpreted.

"When we apply a simple model to data, it indicates that one decision ought to be made," he said. "If we had a better model, we might make a different decision.

"If acoustics are a function of stress," he continued, "then seismic data can illuminate where the completions are efficiently draining the reservoir and where they are not."

Overhauling the Models

Bratton is currently using time-lapse seismic data to build non-linear models tailored for horizontal drilling and hydraulic fracturing in the Wattenberg Field of the Denver Basin. He is working with the Colorado School of Mines and the Reservoir Characterization Project, which integrates the acquisition and interpretation of multi-component, three-dimensional seismic reflection and downhole data with the geology and petroleum engineering of existing oil fields, in an attempt to understand the complex properties of petroleum reservoirs.

By comparing seismic data shot before and after hydraulic fracturing operations, Bratton has seen for himself that acoustical velocities change as a result of stimulation.

He added that production should further chance velocities.

A more accurate velocity model would allow operators to better estimate formation properties and stresses between wells.

"We need to be able to look at seismic data and know where the sweet spot is," he said. "You don't want to drill and miss the good stuff."

Better predictability also might encourage engineers to allocate more funding toward acquiring geophysical data after seeing its benefit to drilling projects.

"When you start making accurate predictions, engineers start to get on board with acquiring geophysical data," Bratton said. "We've got to be friends with these guys and not work on separate floors. We need multidisciplinary teams."

When geophysicists and engineers understand they are working for the same goal, the tug of war that tends to exist between them will likely dissipate.

"Once you prove yourself," Bratton said, "the engineers will be in your office asking for your opinion."

Utilizing the SV mode

Getting More Bang For Your P-Wave

By LOUISE S. DURHAM, EXPLORER Correspondent

When 3-D seismic technology became a must-have tool for the E&P crowd beginning in the mid-1990s, there was considerable scurrying to get up to speed on this then-daunting high-tech application.

Even today, it's not uncommon to see a non-geophysicist's eyes glaze over when a discussion turns to even basic seismic terminology like P-waves, which move through both solid rock and fluids, and S-waves, which travel only through rock.

(Both illuminating and reflective P-wave seismic data, or P-P, have long been used in the industry to evaluate the subsurface.)


HARDAGE

But even geoscientists must constantly be on their toes given that new opportunities always lurk just ahead as advances in seismic technology are ongoing.

AAPG member Bob Hardage, senior research scientist at the Bureau of Economic Geology, Jackson School of Geosciences at the University of Texas at Austin and a past editor of the AAPG EXPLORER's popular Geophysical Corner, is spot-on when it comes to innovation in this arena.

"A more rigorous geologic interpretation can be done if an analysis is based on a joint interpretation of P- and S-wave seismic data rather than limited to a study of only one wave mode," Hardage commented.

"Our Exploration Geophysics Laboratory is focused on providing interpreters wider access to, and lower cost of, S-wave data so seismic stratigraphy studies can be based on multimode seismic data," he emphasized.

"A downgoing P-wave will reflect from an interface as two waves: a P-wave known as P-P, and an SV, or P-SV, called converted shear by some," Hardage noted. "You have to deploy three-component geophones to record (this) because the upgoing SV activates horizontal geophones rather than vertical.

"The new concept introduced by my lab is that ordinary P-wave sources create two downgoing illuminating wave modes: P and SV," he said. "When this wave physics is accepted, we can then utilize a new illuminating wave, the SV mode.

"SV-P data are recorded by vertical geophones," he added, "because the upgoing wave is P."

Translation: More Data, Less Cost

To simplify, SV-P data reside in ordinary P-wave data acquired with vertical geophones, and the SV-P can be extracted. Because thousands of square miles of these common P-wave data are housed in myriad data libraries, geoscientists can evaluate prospects using the indigenous S-wave data without having to record expensive new seismic information.

In fact, the limited acceptance of S-wave reflection seismology has been based primarily on a couple of factors:

- Added cost to acquire S-waves over and beyond the expense to acquire P-wave data alone.
- S-wave sources are essentially limited to horizontal vibrators, which can't be used on many surfaces, such as swamps, marshes, rugged mountainous terrain.

Because it's now documented that S images can be made from either legacy or new P-wave data, the cost issue becomes moot.

As for the source limitations, SV-P technology allows some type of P-wave source to be used in locales having challenging terrains. For example, Hardage noted that shothole explosives produce significant downgoing SV in addition to downgoing P.

Vertical vibrators are another option.

Hardage referred to a study of the lower Permian Age Wolfberry unconventional reservoirs on the Fasken C-Ranch property located on the western platform of the Midland Basin. He noted that the laterally expansive, thin beds of the formation represent ages of turbidite action.

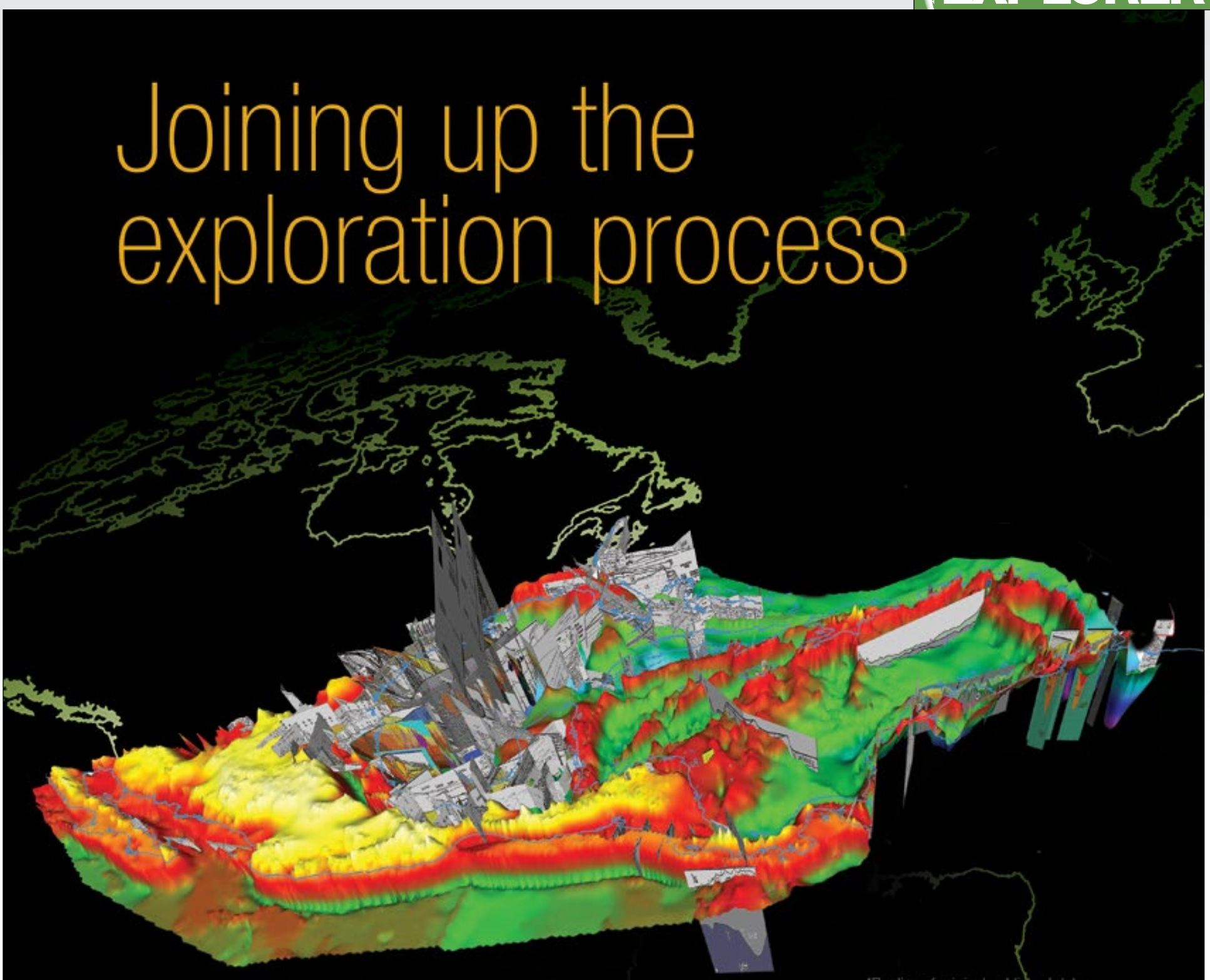
"The principle we observed in interpreting the Fasken seismic data was that SV-P data show the greatest population of turbidite-like depositional elements," he said, "with P-P data showing the next highest population and P-SV data being a distant third in revealing turbidite reservoir architecture.

"This is the first-ever example of SV-P data extracted from pure P-wave data and used to evaluate a prospect," Hardage emphasized.

"We have now done three SV-P studies and are ready to push the commercialization of this new concept for S-wave imaging."

He noted that four patents have been issued to the UT Board of Regents, and UT's Office of Technology Commercialization is pushing ahead to commercialize the technology.

Joining up the exploration process



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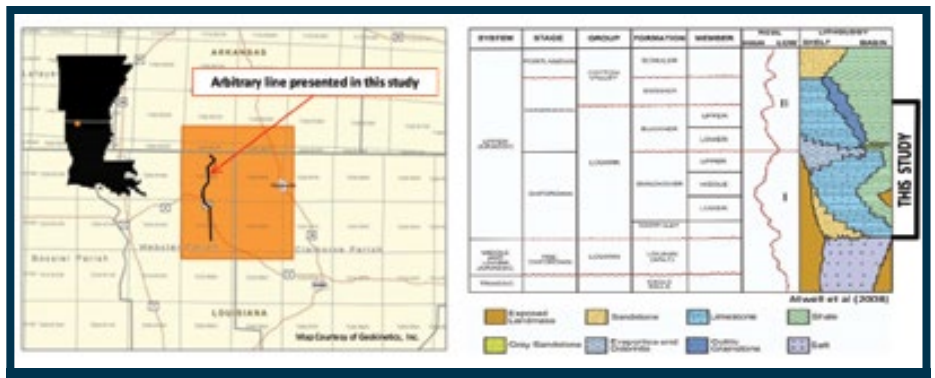

Location of Millerton 3-D survey (left); general stratigraphic column (right) of Upper Jurassic.

Old formation, new tech

Smackover Revisited

BY LOUISE S. DURHAM, EXPLORER Correspondent

The Upper Jurassic Smackover formation in northern Louisiana and surrounding states has been explored and drilled for decades, yielding considerable volumes of hydrocarbons.

Early on, the action entailed the penetration of large structures. This was done by mapping shallower horizons or with 2-D seismic data.

As drilling progressed, it became apparent that the Smackover depositional system was far more complex than initially thought.

A more sophisticated approach was needed to decipher the challenging geology.

"As the geologists' understanding of system variability improved with well density, the same improvement was not readily apparent in the seismic imaging of these complex architectures until fairly recently," said AAPG member Jeffrey Ross, senior geophysicist at Whiting Petroleum Corp.

ROSS

Whiting is studying a part of the Smackover area looking for unconventional opportunities in the Lower Brown Dense zone in the Lower Smackover and some shallower secondary conventional targets.

To that end, a serendipitous event occurred up front.

"Geokinetics called and said they were going to shoot 3-D in the area," Ross said, "and the map they drew covered a lot of our acreage, so we said we're in."

He noted that the ensuing non-exclusive Millerton survey shot in 2013-14 covered approximately 205 square miles in North Louisiana between the towns of Haynesville, Springhill and Homer.

"Robust field acquisition procedures yielded superior quality field data, and modern PSTM processing resulted in excellent structural delineation of complex fault-block geometries associated with underlying Louann salt movement," Ross noted.

A processing stream was initiated parallel to that of Geokinetics, and the final unfiltered product of this stream was handed off to Geotrace to apply their proprietary BE bandwidth extension processing.

"It was our opinion that (their) utilization of the continuous wavelet transform, or CWT, to increase bandwidth would be superior to using typical industry techniques," Ross said, "in that the CWT should theoretically improve signal-to-noise in the extended frequencies."

The final bandwidth extended data set was "tested" by applying the relative colored acoustic impedance inversion technique, which can be used for high-resolution qualitative analysis.

He offered a brief overview of some of the considerable information derived from the Smackover seismic effort overall.

"Results of this test revealed an excellent correlation of the band-limited acoustic impedance with the known Smackover carbonate intervals penetrated by well control," Ross said. "It was extremely useful in aiding the interpretation of the higher order sequences.

"The high frequency imaging afforded by the bandwidth-enhanced 3-D seismic volume reveals a complicated interplay between accommodation, or volume, driven by relative sea level and syndepositional salt movement," he added.

"Loading of the Louann salt during progradation of Upper Smackover clinoforms resulted in areas of increased accommodation where salt was being evacuated," he noted, "and, conversely, areas of decreased accommodation in areas on salt ridges.

"As the Upper Smackover prograded across these salt ridges, a departure from ramp geometry is observed, and clinoforms become steeper and develop a pronounced break in slope," Ross continued.

Following the Upper Smackover deposition, faults cut through the entire sequence immediately downdip of salt ridges, according to Ross. This activity resulted in large displacement synthetic listric normal faults that sole out in the Louann salt.

The Millerton 3-D seismic acquisition survey – along with the subsequent application of special bandwidth extension processing and inversion to these data – has proven to be an invaluable assist to the geoscientists interested in the area.

Ross itemized a number of conclusions reached for the project:

- Good 3-D seismic is never a bad idea in areas with complex geology.
- Bandwidth extension isn't voodoo.
- Relative colored inversion is cheap, quick and supplies a strong uplift in interpretability of areas of rapid facies change.
- Global eustasy is not the only significant driver of Smackover deposition; local tectonics and halokinesis have a role as well.
- Classic Smackover A, B and C nomenclature obfuscates a much more complex depositional architecture.

"This has conclusively demonstrated," he added, "that seismic acquisition and processing in the Smackover of northern Louisiana has finally caught up to the level of detail available to geologists in this complicated and intriguing area."

Irv Tailleur and Gil Mull, enjoying their work in the DeLong Mountains of Alaska's Brooks Range, July 1975.

Déjà-vu in Alaska

How to Survive a Crash

By HEATHER SAUCIER, EXPLORER Correspondent

As the number of layoffs in the industry continues to climb in inverse proportion to falling oil and gas prices, many can't help but dredge up memories of 1980s oil glut – when thousands lost their jobs.

Now retired, five geologists from the Alaska Division of Geological & Geophysical Surveys (DGGS) – the research arm of the state's Department of Natural Resources – recall when their budget was slashed by two-thirds, resulting in rampant layoffs that threatened to render their organization obsolete.

Yet their story isn't lost in thousands just like it. It is one for the books.

"We felt we were contributing an enormous amount to the state by our assessment of state land and resources and their revenue potential for Alaska," said Thomas E. Smith, former state geologist and former senior geologist at the DGGS during the time of the crunch. "If you accept that premise, then you can see how it was important to preserve the heritage and knowledge and continuity we had."

Determined to find a way around strict state and union protocols, employees of the DGGS unanimously volunteered to take long stints of unpaid leave for two years to halt layoffs and ultimately save their work from obliteration.

"It was an incredible illustration of a really cohesive organization at that time," said AAPG member Gil Mull, who worked for the DGGS from 1981 to 2001.

I doubt you would get that sort of unanimity today," he added. "It was quite extraordinary."

Friday Night Massacre

When the price of oil dropped to less than $10 a barrel in the mid-1980s, Alaska was the first state to feel it, as an average of 85 percent of its revenue comes from the petroleum industry, according to the Alaska Oil and Gas Association.

The Department of Natural Resources was the primary target for massive layoffs, and the DGGS was the bull's-eye.

It all started in 1986 when oil prices dropped 46 percent and the DGGS' budget was slashed from roughly $27 to $7 million. Late that summer, geologists working in the Arctic National Wildlife Refuge were pulled from the field and told they no longer had jobs, recalled Ellie Harris, who worked as a geologic assistant for the DGGS at the time.

"I always say we went from 140 people to 40 people with the stroke of a pen overnight," she said.

Not too long after, a group of roughly nine geologists and geophysicists returned from a tin granite mapping project near Nome Creek. All were laid off as they climbed out of their helicopters one Friday evening, said former AAPG member Gar Pessel, a geologist who served as the DGGS' section chief for minerals investigations at the time.

Called the "Friday Night Massacre," the firings awoke Pessel to the fact that the DGGS was rapidly being decimated.

Some believed the commissioner of the Department of Natural Resources, Esther Wunnicke, had a grudge against the DGGS. Others knew that in times of financial crises, research organizations become the most vulnerable.

Speculations aside, "Everybody pulled together and said if we let these cuts continue to go through, we will not have a survey," Pessel said.

"It shows dedication to the science," he added. "If you're immersed in the science, it doesn't take a genius to figure out what is important."

A group of senior geologists, including Smith and Pessel, turned into overnight politicians. They mentally mapped a way around state and union roadblocks, which did not sanction seasonal positions and required junior employees and support staff to bear the brunt of layoffs – part of the union's senior members' "bumping rights," Harris recalled.

"The future of the survey was not a bunch of people in their 50s sitting around a table. The future was in the people just beginning their careers – the junior geologists," Pessel said. "It takes some years for a geologist to acquire the knowledge and experience to be able to really contribute to the science and the needs of the state."

Where There's a Will …

The senior geologists presented a plan

See **Survival**, page 24

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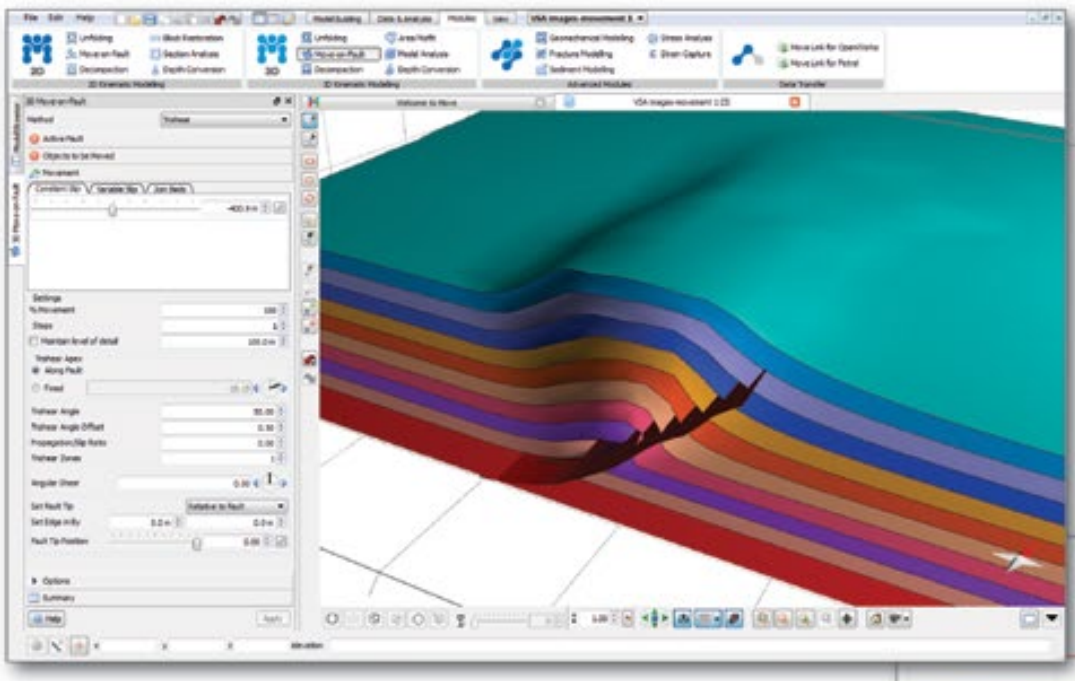

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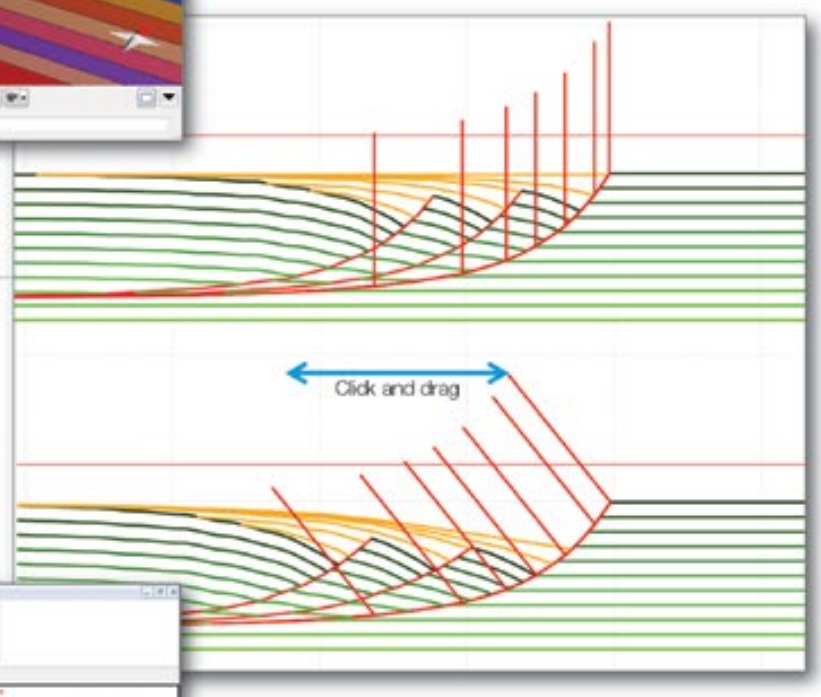

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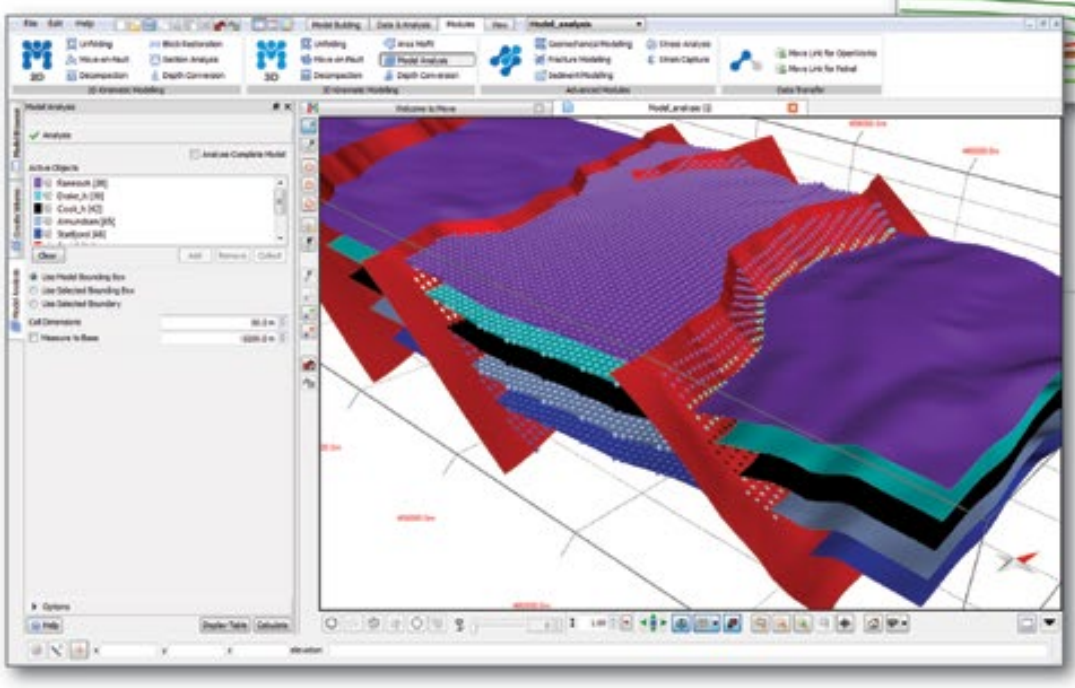

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Taylor Fellows Shine Spotlight on the State of AAPG Publications

By BEVERLY MOLYNEUX, Technical Publications Managing and Commissioning Editor

The pursuit of scientific and technical excellence in publishing was once again addressed and celebrated as 27 Fellows and AAPG staff members met in Houston for the third annual Charles H. Taylor Fellowship meeting.

The one-day meeting, held in early February under the leadership of elected editor Michael L. Sweet, allowed the group to focus on not only at the state of AAPG publications in 2014, but also at the future of publications.

Items of discussion included:

AAPG Publication Awards

Building on last year's Fellowship meeting determinations of what constitutes a "best paper," deliberations took place surrounding the next set of Sproule, Dott and Pratt award winners.

Balloting that had taken place in the two months preceding the meeting had narrowed down the candidate lists for each award. Winners are yet to be announced.

BULLETIN

Last year a record number of 240 papers were submitted for peer review and the publication of two Special Issues.

Also discussed was the upcoming launch of an AAPG Publications App for app-based delivery of the BULLETIN. The app, which will be free to members, is currently being bid on by app developers and will be available by Jan. 1.

DEG'S Geosciences Journal

The Environmental Geosciences journal's new editor-in-chief Michelle Cooney gave a brief presentation on the journal and the Division's current activities.

The Division also promotes AAPG and DEG through a quarterly newsletter addressing current events in energy and environmental issues; coordinates field trips, short courses and workshops; and works to educate and engage the public and scientific communities on relevant issues in energy and the environment.

INTERPRETATION Journal

A brief update and a question-and-answer session on the SEG/AAPG journal was given by editor-in-chief Younghe Sun. The journal, launched August 2013, continues to gain ground and grow in content with each new issue. Submissions remain strong.

Books

A new AAPG Books Editorial Board was announced to take the place of the former Publications Committee. The Board's primary mission is three-fold: Provide geo-technical analysis on Memoir topics; assist and advise Memoir compilation editors; and review chapters and reviewers for each Memoir.

The new board will be led by William D. DeMis, a former chair of the Publications Committee, and is tasked with scientific oversight of all AAPG Memoirs.

Survival

from page 22

to a new DGGS director, Robert Forbes, that showed an unwavering solidarity:

The highest-paid geologists offered to take three, four and five-plus months of unpaid leave in 1987 and 1988 to fund the salaries of the junior geologists and clerical staff who faced the chopping block. Employees farther down on the payroll would take less time off, as they couldn't afford drastic cuts in salary.

To fund mapping projects, the senior geologists planned to appeal to the industry, universities and the U.S. Geological Survey for assistance.

Although all DGGS employees unanimously signed a memorandum of understanding showing their commitment, the Department of Natural Resources and the union "fought us every inch of the way," Pessel recalled.

"It was a time of scientists getting involved with politics, which made me grit my teeth," Harris said. "But they saved the agency in doing so."

With much persistence, Forbes eventually convinced the Department of Natural Resources to find a way to convert full-time permanent positions into part-time permanent positions, in accordance with state and union rules.

Mull was paid by the DGGS for five months of the year and received a special approval to perform non-competing contract work with Atlantic Richfield Company to supplement his income.

Smith, who recalled giving up either three or four months of pay, continued to go to the office every day. In fact, when trying to file for unemployment, he was rejected because instead of looking for another job, he allocated his time working for the DGGS for free.

"Some people were so incredibly involved with the projects they were working on that they kept doing them," Mull said.

Harris found work at the USGS. To keep her position at the DGGS, however, she returned for one month each year to help compile the first Dalton Highway Visitor Guide.

Despite the salary cuts, all of them managed. "You might remember how it was in college," Smith said. "You find a way."

Stretching the Budget

Through sacrifice, the DGGS managed to preserve its core geologists.

See **Grants**, page 26

Geologists Ellie Harris (center) and Grant Spearman in Alaska's Anaktuvuk Pass, July 2002.

Geological field crew, keeping busy in the western Endicott Mountains, 1991.

Grants

from page 24

A group of companies that included Arco, British Petroleum, Anadarko and others regularly granted amounts as large as $40,000 each to the organization's research on the North Slope. The grants paid for much of the helicopter contracts and field camp expenses for mapping projects necessary to assess Alaska's oil and gas inventory for purposes of land-use management, Mull said, clarifying that the information gleaned from such projects was not shared with the grantors prior to its release to the public.

"It's a waste of the scientists' talent to chase money," she said. "It's not the best use of resources."

Eventually, as oil prices rose again, the DGGS was free to pursue projects without having to regularly hold its hands out for money.

Avoiding a Sequel

Alaska Gov. Bill Walker recently proposed cutting 329 state jobs and the DGGS' budget by 18 percent. If the downtrend in oil prices continues, more cuts likely will be made next year.

"This has all the makings of a traumatic time comparable to that of the mid-'80s," Mull said.

Tom Bundtzen, a former DGGS geologist and owner and president of Pacific Rim Geological Consulting, shares the same concerns, but stresses one major difference between the oil glut decades ago and today's downturn in the market.

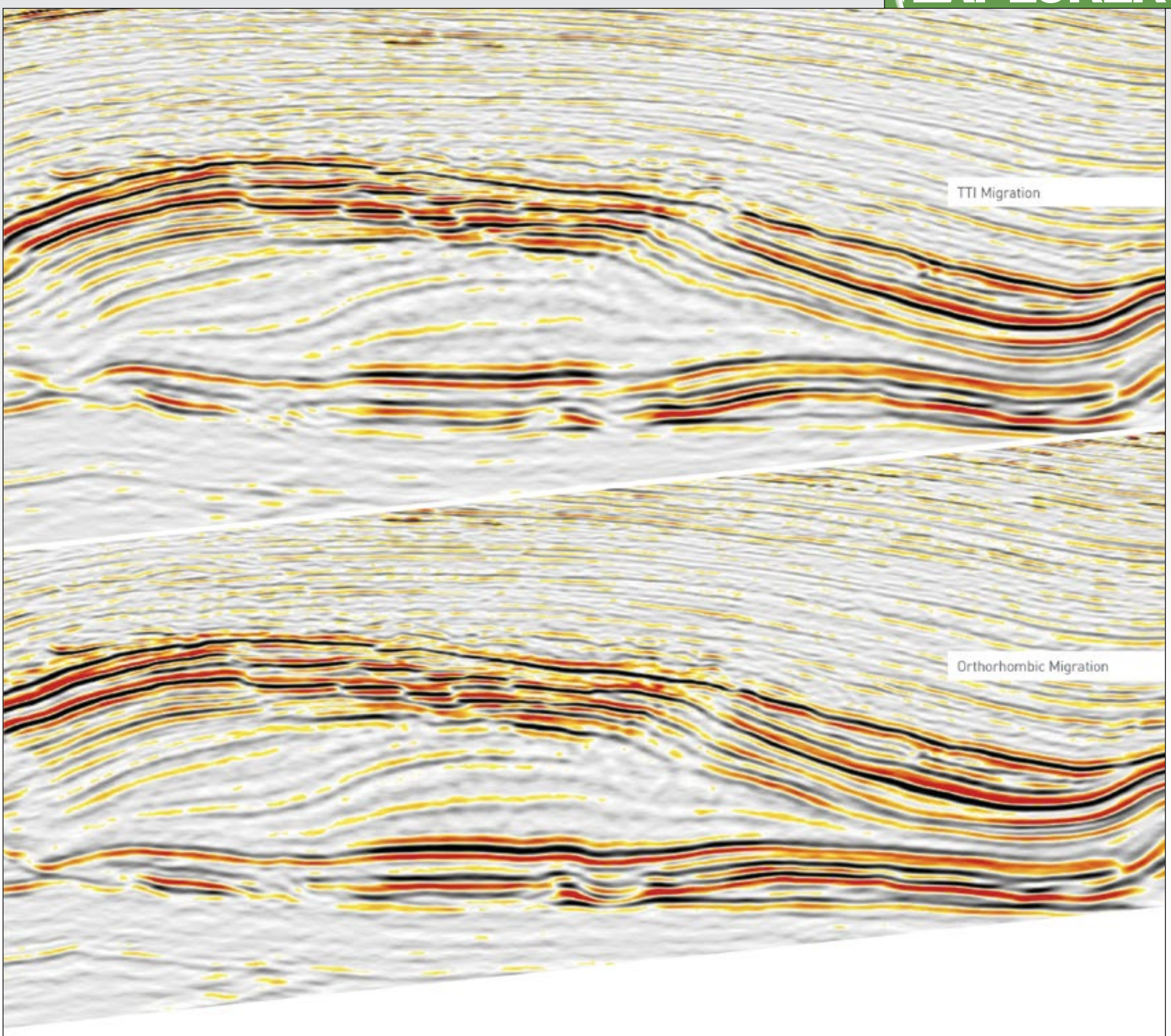
Monetary reserves in several state accounts currently total more than $10 billion," Bundtzen said. "This should help cushion the impacts of trimming state programs, a necessity during this time of declining oil and gas revenues.

"In contrast," he continued, "during the late 1980s there were negligible reserves in the state accounts, which necessitated drastic cuts in state programs."

If times get tougher, would DGGS employees pull together once more in unanimous solidarity?

Current DGGS Director Steve Masterman could not be reached for comment, but if the organization is anything like it was in the 1980s, anything seems possible.

"We were a tight knit group," Smith said. "We were going to make it work. It was a family. You don't lay off your family."



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Survival of the fittest?

Seismic Killed the Paleo Star

By HEATHER SAUCIER, EXPLORER Correspondent

Comparing the critically endangered species of the Black Rhino or the Amur Leopard to a paleontologist is not necessarily a far-fetched analogy: The paleontologist is a dying breed in the oil and gas industry.


ARMENTROUT

This fact is not new, but it is quickly reaching a critical point. Retirement lies just ahead for the small pool of micropaleontologists still employed by major energy companies or who work as independent consultants.

With few remaining experts in biostratigraphy and paleoecology – two subsets of the discipline that determine the age of rocks and the environments in which they were deposited – many say operators will soon find themselves in a quandary.

"It's definitely a problem, and it's only a matter of time before the full effects are seen," said AAPG member Nancy Engelhardt-Moore, a paleontologist with ALS Ellington in Houston.

"This is a critical topic. When you drill a well, you've got to know where you're going, and rocks are the best records," she said. "It's called the 'ground truth.'"

Despite the fact that many paleontologists were laid off during the economic downturn in the mid-1980s and then passed over for geophysicists in the 1990s when 3-D seismic proved highly valuable for identifying drilling locations, many geologists insist they are as indispensable today as they were decades ago.

"There's no question about their value," said AAPG Honorary member John M. Armentrout, a retired exploration geologist and past AAPG vice president who co-authored several reports on the need for highly specialized paleontologists when their numbers began plummeting. "Paleontologists continue to play a valuable role in exploration and production.

"Even as technological changes sweep the industry," he continued, "integrating paleontologic data with these new technologies, such as 3-D seismic, should be a standard practice."

The thinning of paleontologists from the industry could simply be seen as a product of natural selection.

However, scientists – who have witnessed countless dry holes as a result of a dearth of paleontological data – are challenging any notions related to the survival of the fittest.

In fact, many are currently brainstorming ways to sustain the languishing science and the people who practice it.

On the Verge of Extinction?

When crude oil prices dramatically dropped in 1986, marking an end to the oil glut, paleontologic staffs at major U.S. oil companies shrunk by 90 percent, leaving most companies at levels well below critical mass, Armentrout co-wrote in a report, "Fossils in the Oil Patch" (October 2000 Geotimes magazine).


Early Middle Jurassic ammonite from a core slab at a depth of 2,436 feet in the Bear Creek #1 well, Alaska Peninsula.

ExxonMobil employed approximately 100 paleontologists more than three decades ago. Today, fewer than 10 remain on staff, said AAPG member Keith Knabe, a biostratigrapher who has seen many cut-backs during his 34-year career.

The trend also hit the nation's universities. During the late 1950s, paleontology was the number one area of graduate study in North America, according to a 1997 report by the U.S. Department of Labor.

Today, there are fewer than 50 graduate professors of micropaleontology in the United States, said David Watkins, professor and chairman of the Earth and Atmospheric Department at the University of Nebraska, who also compiles data for the American Geoscience Institute's Directory of Geoscience Departments.

Since 2012, just 28 institutions have had graduate programs in micropaleontology – a decrease of roughly 40 percent between 2001 and 2011, Watkins added.

"In general, micropaleontology doesn't bring in as much money at the graduate school level as other disciplines do, especially as state support dries up and it gets harder to obtain research grants from the National Science Foundation," he said.

And, mirroring the issues in the industry, professors of micropaleontology are retiring as well.

"It's something universities are going to need to come to grips with," he said. "Companies are still hiring these people. My students graduate with more than one job offer. It's just a matter of securing industry funding for research to support students' graduate studies in micropaleontology."

Furthermore, today's students are drawn to cutting-edge technology in geophysics, reservoir modeling, chemostratigraphy

See **Graduate Programs**, page 32

Online Registration Open for Denver ACE

Online registration is now open for the AAPG Annual Convention and Exhibition, which will be held May 31-June 3 in Denver at the Colorado Convention Center.

And those who register by April 6 can save up to $210 on their registration fees.

Student fees and one-day pass payments also are available.

"Exploring the Summit of Petroleum Geosciences" is this year's theme, and organizers have compiled a program that features more than 900 technical presentations, 18 short courses and 13 field trips to present a comprehensive experience.

Other highlights will include:

- Hundreds of feet of core from major petroleum plays will be on display at the core poster sessions.
- Author Simon Winchester celebrating the 200th anniversary of "The Map That Changed the World" will be featured at the All-Convention Luncheon.
- Former U.S. Geological Survey senior scientist (and AAPG member) Tom Ahlbrandt will be presenting this year's Halbouty Lecture, "From Petroleum Scarcity to Abundance: Opportunities and Implications for the U.S. and the World."
- Several special technical sessions will be held, including the next two installments of AAPG's "Discovery Thinking" forum series – one on Global Discoveries, and one on North America Discoveries.
- Three Division luncheons are planned, offering topics such as Alberta's Oil Sands, the "Evolution of Unconventional Oil Plays" and "Can Unbiased Science Prevail?"
- The opening session and awards ceremony, where the best of AAPG will be honored. Among the honorees will be veteran geologist Paul "Mitch" Harris, who will receive the AAPG Sidney Powers Award, AAPG's highest honor, and Alfredo Guzman, winner of this year's Michel T. Halbouty Leadership Award.
- An exhibit hall featuring more than 250 companies who will display the latest in technology, science and services.

To register or for more information, go to ace.aapg.org/2015.

Graduate Programs

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and detrital zircon studies – pushing paleontology further into the realm of the old school. Three-D seismic, which relies on reflective seismic waves to draw a detailed roadmap of the subsurface, is often hailed by the petroleum industry as a cure-all, said AAPG member Robert B. Blodgett, a consulting paleontologist based in Anchorage, Alaska.

As useful as 3-D seismic can be, however, like any dataset, it has its limitations.

New Technology, Same Ol' Problems

Along the Gulf Coast and in the Gulf of Mexico, paleontologists have examined well cuttings for more than 70 years and recorded thousands of biostratigraphic and paleoecological data points. However, most of these data points don't extend below depths of 8,000 feet, leaving operators to choose between 3-D seismic and biostratigraphy when building a basin framework.

Oftentimes, they place more faith in seismic, not wanting to spend money on both, Engelhardt-Moore said.

The biostratigraphic analysis of a well costs tens of thousands of dollars compared to seismic's multi-million dollar price tag. But in the eyes of Armentrout, "Misinterpretations of seismic data can limit or even negate its value."

As operators continue to push the boundaries of drilling in remote places and deeper waters, they are finding that data from 3-D seismic is not always reliable.

"Today we have a situation where we have a shortage of paleontologists and we've discovered in the last 10 years or so that when drilling in the subsalt of the Gulf of Mexico, seismic doesn't work so well," Engelhardt-Moore said, explaining that it tends to give false images when its waves run through salt formations.

"Seismic is interpretive, and people don't like to think this because they've spent so much on seismic and then learn it's not always accurate," she said.

"However, if you run the rock samples and analyze the microfossils, you'll see they are tried and true," she added. "They can tell you where you are in the basin."

Recent lessons learned in the Gulf of Mexico aren't much different from other lessons learned long ago. Alaska's Bear Creek No. 1 Well, which was featured in the June 2014 EXPLORER, is a classic case of a disaster that can happen in the absence of paleontological data, Blodgett said. Drilled in 1957 and plugged just two years later, the well became known as the most expensive dry hole in North America in the 1950s at $7 million.

Some blame the well-site geologists who didn't thoroughly test the rocks during drilling and overshot the targeted horizon by roughly 7,000 feet.

Blodgett works regularly with clients whose interpretations of seismic data in terms of formation picks can sometimes be off by as much as 50 million years, causing them to produce incorrect models, drill dry holes, abandon leases and waste millions of dollars.

"In order to know with certainty that you are drilling in the right place, you need to know the age of the rocks, and this can be done by looking at the fossils," Blodgett said. "You really want to know where your target is. You want accuracy. Age is everything in this game."

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Change
from page 32

Micropaleontology is classical training that most young scientists lack, and they struggle tremendously, especially when trying to locate hydrocarbons in new frontiers, Blodgett said.

"We've lost touch with rocks," he said. "Kids fresh out of school often don't know what rocks in the field look like."

Geology on the Rocks

When companies bypass the analysis of paleontologic data, many end up simply "putting holes in the ground," Engelhardt-Moore said, adding that while it is undoubtedly more expensive to rely on multiple datasets, it can actually be more cost beneficial in the long run.

When building a basin framework, ideally, operators should incorporate biostratigraphy, well logs, seismic, lithology, hydrocarbon type, geochemistry, rock properties, ages and paleoenvironments, she added.

Paleontologist Mike Styzen of Noble Energy spent the first 12 years of his career looking through a microscope at thousands of microfossils – a process dating back to the 1920s when micropaleontology was first applied in the petroleum industry. He has worked with foraminifera, nannoplankton and palynomorphs – the three main microfossil groups – identifying traps, seals and source rocks, all of which point operators to the sweet spots.

It's fair to call Styzen a rare bird, as he has compiled an irreplaceable knowledge bank and skill set and has provided invaluable correlations to other datasets for optimal basin modeling.


STYZEN

> "No one has invented a machine yet that can identify microfossils."

For years, paleontology was limited to exploration, and paleontologists worked quietly behind the scenes. They supplied other scientists with information so it could be correlated with other data.

In the last 15 years, however, paleontologists have been playing a front-and-center role during production – ever since companies realized that seismic alone can't accurately map the salt formations in the deep Gulf of Mexico, Styzen said.

Having once worked on the Gulf's off-shore drilling rigs identifying fossils from cuttings and making major drilling decisions on the spot – Styzen noted that paleontology is getting its second wind.

Managing to operate with a skeleton crew of paleontologists over the years, companies soon will be facing a slew of ripple effects from attrition.

Like many, Styzen's retirement lies just around the corner, and he expresses concern about how the industry will press on without paleontologists' expertise and efforts to mentor young scientists joining their teams.

"You need a good four or five years of looking through a microscope at fossils in one particular specialty to become proficient," Styzen said. "That's the importance of having a mentor. You need someone to check your work. In the industry, a lot of this stuff isn't written down. It's an oral tradition of sorts, handed down from mentors to protégés."

Styzen has mentored many people over the years, including those with whom he currently works.

"Mentors are extremely important right now," he reiterated. "Sooner or later, I'm going to have to start training people, because a lot of them have never been exposed to micropaleontology – even at school."

Counting fossils is labor-intensive work, and as Styzen noted, "No one has invented a machine yet that can identify microfossils."

In the eyes of Armentrout, the key to reviving the appreciation of paleontology lies in undergraduate education:

"Undergraduates exposed to the usefulness of paleontologic data for solving geologic problems will expect to use such data during their careers, no matter their career track," he wrote in "Fossils in the Oil Patch."

However, universities won't hire professors if students can't find jobs," Knabe pointed out.

"A company just can't commit to a university and say, 'We will hire all the paleontologists you produce,'" he said. "It's definitely a Catch-22."

Staging a Comeback

While Armentrout noted that the mentoring of new scientists by highly experienced staff is "almost extinct," paleontologists are working to keep mentorships alive.

Part of Engelhardt-Moore's job description includes training young scientists. She also volunteers as a docent at the Houston Museum of Natural Science's Morian Hall of Paleontology, explaining the importance of the science to any visitor who will lend her an ear.

Another tactic she uses is fishing abroad for viable candidates.

"We've sent out ads worldwide and have been locating people both in the United States and other countries who have just graduated in paleontology," she said.

The ALS Ellington staff now includes young graduates from Russia, Libya, Iran and Italy, where graduate degrees in micropaleontology are more widely offered.

In fact, the United States may be employing more paleontologists from Russia – "Things are much better for paleontology (there) than in the United States," Blodgett noted.

His colleague, Boris Nikitenko from the A.A. Trofimuk Institute of Petroleum Geology and Geophysics in Siberia, recently reported that roughly 60 paleontologists are studying the stratigraphy and evolution of Siberian petroleum sedimentary basins.

"Maybe this explains why they are one of the leading exporters of oil globally, while we are still trying to recover from our energy crises with the shale oil boom," Blodgett suggested.

"America must learn how to re-grow its former scientific excellence," he said, "but I don't see an easy solution.

Historical Highlights is an ongoing EXPLORER series that celebrates the "eureka" moments of petroleum geology, the rise of key concepts, the discoveries that made a difference, the perseverance and ingenuity of our colleagues – and/or their luck! – through stories that emphasize the anecdotes, the good yarns and the human interest side of our E&P profession. If you have such a story – and who doesn't? – and you'd like to share it with your fellow AAPG members, contact Hans Krause at historical.highlights@yahoo.com.

Spindletop Was Feted, And She Met a Hero

By ELLEN WALKER RIENSTRA

I must have tugged on his coattails.

Actually, I don't really remember how it all came about. But at the 1951 Spindletop 50th anniversary celebration in Beaumont, Texas, I, a 10-year-old schoolgirl, somehow found myself talking to Allen William "Al" Hamill, one of the drillers of the famed Lucas Gusher – the well brought in 50 years before, January 10, 1901, on the low mound just south of town that came to be known as Spindletop Hill.


RIENSTRA

On that cold January day in Beaumont, the well had come in at a time and in a world that knew no oil gushers – except for the occasional vague news mention about giant wells in Russia, unnoticed or only half-believed by most Americans.

A "big" well in the eastern oil regions, or even in the lone small oil field at Corsicana in Texas, produced 50 barrels a day. But the Lucas Gusher spewed forth 70,000-100,000 barrels of oil a day in the nine days before they invented a way to cap it (with a device the Hamill brothers invented on the spot – a primitive precursor of the Christmas tree valve assembly).

It was this well – the Lucas Gusher – that first gave the world the idea that oil might be available in unlimited quantities.

Its roaring column of oil produced twice as much oil per day as all the wells in Pennsylvania. It heralded the birth of the Spindletop oil field, the first six gushers of which produced more oil per day than all the other fields in the world combined.

The sheer volume of oil produced at Spindletop pushed Russia out of the top spot in world production and gave the lead to the United States. And if that volume of oil was found at Spindletop, surely more lay hidden in other places nearby, there for the finding, and more fields were soon discovered in Texas – and beyond.

Three major oil companies were formed at Spindletop – Gulf Oil Corp., Humble Oil Co. and the Texas Co. (later Texaco) – and a fourth, Sun Oil Co., grew to major proportions in the wake of the discovery.

The global import of Spindletop would be brought home with the realization that in 1911, only 10 years after the advent of the Lucas Gusher, British Home Secretary Winston Churchill would convert British Navy ships to the use of petroleum-based fuel – all because of the abundance of Texas oil.

Quite simply, the advent of the Lucas Gusher changed the course of history.


Photo courtesy of Tyrrell Historical Library, Beaumont, Texas.

Pattillo Higgins, left, the Beaumont prophet of Spindletop, and Al Hamill at the Spindletop 50th-Anniversary Celebration in Beaumont, Texas.


Photo courtesy of Texas Energy Museum, Beaumont, Texas.

The iconic shot of the Lucas Gusher, taken Jan. 10, 1901, by Beaumont photographer Frank J. Trost. This photo would shortly be seen all over the world. Anthony Lucas stands proudly on the right.

Going Against the Grain

The well was brought in by Capt. Anthony Francis Lucas, an Austrian mining engineer who had observed the association of salt, sulfur, gas and oil while mining in the salt domes of Louisiana.

Lucas recognized Spindletop Hill as a salt dome and concurred with the arguments of Pattillo Higgins, a Beaumont resident with his own theories of oil under the hill.

Going contrary to the existing tenets of American geology, which held that the Gulf Coast was geologically too young to host the presence of oil, Lucas and Higgins made a first drilling attempt – but the well was destroyed by the enormous gas pressures under the hill.

Lucas, undaunted, secured the support of wildcatters John Galey and James M. Guffey and the financial backing of Pittsburgh's Mellon Brothers. He also recruited the best drillers available: the Hamill brothers of Corsicana – Al, Curt and Jim.

The combination of these personalities, with their diverse gifts, ultimately ensured success.

And the rest, as they say, was history.

Bring In the Celebrities!

My personal link to Spindletop had begun almost before I can remember, when the mystique of the Lucas Gusher lay deep in the fabric of all our lives in Beaumont. The tale had been told regularly by all and sundry, and it had rapidly acquired the status of myth. It was never far from community consciousness.

On the 40th anniversary of the Gusher its original site, which had been lost in the subsequent scrambled fury of drilling, was located and commemorated by a towering obelisk of pink Texas granite.

In anticipation of the 50th anniversary, Beaumont envisioned a giant celebration, and preliminary plans began more than two years in advance.

As the anniversary drew nearer, excitement ran high throughout southeast Texas. As a 10-year-old fifth-grader, I myself remember feeling it.

- We studied the story of the Gusher and its principal players in school.
- We painted its image in our art classes.
- We entered essay contests sponsored by the Spindletop Planning Commission.
- The town fathers in Beaumont and those in surrounding communities mapped out their parts in the festivities.
- Beaumont hairdressers fashioned their customers' tresses into "Spindletop" hairdos, and a local ice-cream parlor featured "Lucas Gusher" sundaes – with an abundance of chocolate sauce cascading down the piled mounds of ice cream.

The week of the actual anniversary commenced with a broadcast of "We the People," the national radio and television show of the Gulf Oil Corporation, featuring my personal Spindletop hero, Al Hamill, who recounted the tale of drilling the Lucas Gusher. Beaumont's noted singing group, the Melody Maids, staged a "Spindletop Revue," presenting music composed by the group's director, Eloise Milam.

DuPont's national radio show, "The Cavalcade of America," broadcast from Beaumont in front of an enormous live audience, with entertainment figures Robert Cummings and Teresa Wright in the roles of Anthony Lucas and his wife, Caroline.

We attended or listened to every show or broadcast, viewed every exhibition, participated in every activity.

That week, Beaumont again stood at the center of national attention. Celebrities and dignitaries poured into town, among them Texas Gov. Allan Shivers, famed geophysicist Everette DeGolyer (who had been a personal friend of Anthony Lucas), and oilmen Glenn McCarthy and legendary geologist Michel Halbouty, the latter a native son of Beaumont.

A Moment In Time

The morning of Jan. 10, 1951, dawned clear and cold, much like that other January morning of 50 years before.

At 10:30 a.m., refinery whistles and automobile horns all over town blew to commemorate the hour the Gusher had blown in, and a formation of jet planes flew over downtown Beaumont and out over Spindletop Hill. David Rockefeller, the grandson of John D. Rockefeller (whose interests had, before the discovery, declined to invest in the Spindletop wildcat venture) spoke to a Rotary luncheon in Beaumont numbering 500.

The grand finale took place that afternoon with a huge "Parade of Progress" through downtown Beaumont. I vividly remember being delirious with excitement as an endless procession of the region's finest bands marched proudly by, instruments glittering in the sunlight and gargantuan oil industry machines and equipment rolled past.

In addition to Cummings and Wright, three guests of honor led the parade: Anthony FitzGerald Lucas, the only son of the now-deceased captain; 89-year-old Pattillo Higgins, who had first harangued the Beaumont populace about oil on Spindletop Hill, smiling thinly at the vindication of his prophecy; and my hero, the gentlemanly Al Hamill, the driller of the well, still handsome and spry at age 75, smiling genially and waving to the crowds.

After the parade, we all repaired to the Exhibit Hall in the South Texas State Fairgrounds, where a mammoth portrait of Capt. Anthony Lucas presided benignly over exhibit after petroleum-related exhibit portraying the vast impact of Spindletop on the region and the modern world.

It was there that I spotted Al Hamill, talking to some of the many dignitaries who were waiting to catch a few words with him. Somehow, I managed the courage to approach him. He stooped to talk to me, treating me with the kindness and courtesy he would have accorded any peer – or for that matter, anyone.

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Inaccuracies Abound In Emissions Papers

By EDITH ALLISON, Geoscience and Energy Policy Office Director

The oil and natural gas industry is the target of round two of the President's Climate Action Plan, released in 2013 with the goal of reducing greenhouse gas (GHG) emissions.

Round one was the proposed rules limiting carbon dioxide (CO_2) emissions from new and existing power plants. Regulation of methane emissions is now taking center stage.

In January, the administration announced a new goal to cut methane emissions from the oil and natural gas sector by 40 to 45 percent (2012 levels) by 2025.

To help accomplish this, the EPA will propose standards for "methane and volatile organic compounds (VOC) emissions from new and modified oil and natural gas production sources, and natural gas processing and transmission sources."

The proposal is expected this summer.

Review of the EPA's background analysis or white papers, discussed later in this article, suggests that the EPA does not have an accurate estimate of the volume of methane emitted from the oil and natural gas sector. It is hard to imagine how regulators will determine how to capture 40 to 45 percent of an unknown – or what the costs and benefits will be.

The EPA also plans to set guidelines for states to reduce emissions of ozone-forming pollutants from existing oil and natural gas systems in areas that do not meet the ozone health standards.


ALLISON

It is hard to imagine how regulators will determine how to capture 40 to 45 percent of an unknown – or what the costs and benefits will be.

Dallas-Fort Worth would be one major oil and gas producing area impacted under ozone rules.

The EPA may envision regulating oil wells in a process similar to the 2012 standards requiring reduced-emissions, or green, completions to reduce VOCs from natural gas wells – those standards do not set limits on methane emissions. The requirements took effect at the beginning of this year, although many operators have been using green completions for years.

Alternatively, the EPA could seek to regulate methane as a greenhouse gas in a process similar to that used for power plants, by first regulating new sources, then directing the states to constrain existing sources.

In addition, the administration expects the Bureau of Land Management (BLM) to issue new standards for hydraulic fracturing on federal lands in late February. These standards have been in development since 2012.

The administration says the BLM standards will reduce wasteful venting, flaring and leaks of natural gas from new and existing oil and gas wells.

This statement suggests that the new standards will go beyond the 2012 draft proposal that only considered hydraulic fracturing chemical disclosure, well bore integrity and management of flow-back waters.

EPA White Papers

In the spring of 2014, the EPA issued a set of five white papers listing methane and VOC emissions sources and possible leak mitigation technologies for:

✓ Compressors.
✓ Oil well completions and production.
✓ Pneumatic devices.
✓ Leaks.
✓ Liquid unloading.

These documents form the justification for the upcoming rules.

This column will look only at the oil well completions and production white paper: "Oil and Natural Gas Sector Hydraulically Fractured Oil Well Completions and Associated Gas During Ongoing Production."

The white paper describes the existing, extremely limited emissions data and extrapolates to national emissions volumes or targets for mitigation.

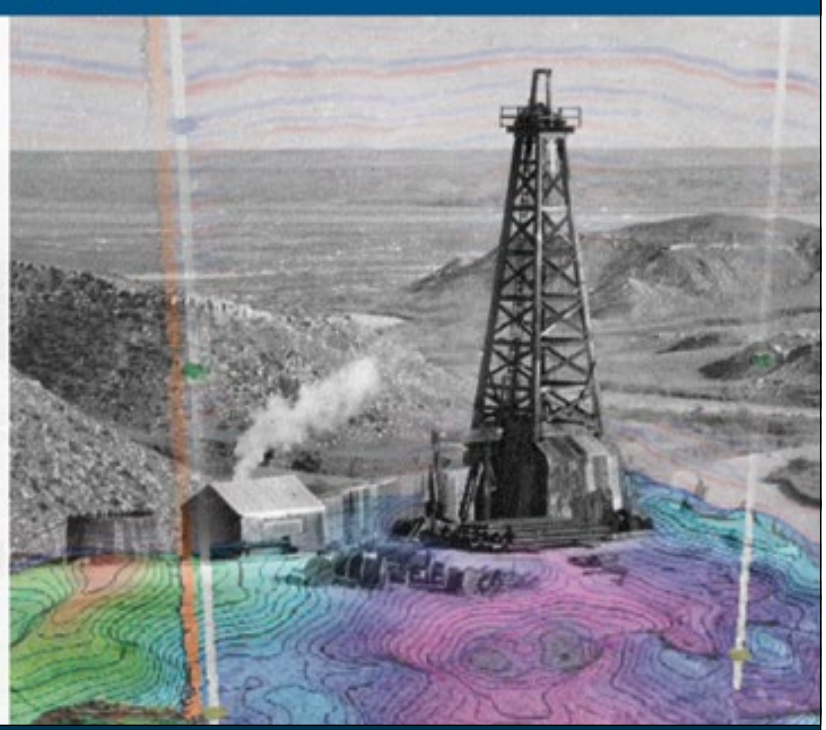
The papers also describe emissions mitigation technologies and estimate their effectiveness.

The EPA has attempted to estimate how much methane and VOC would be emitted during oil well completions, based on assessments of commercial oil and gas production databases and one peer-reviewed study of 26 well completion events in the Gulf Coast, Mid-continent, Rocky Mountain and Appalachian regions (Allen et al, 2013, Measurement of Methane Emissions at Natural Gas Production Sites in the United States).

In addition, industry – as well as academic, regulatory and environmental organizations – faults the white papers for incorrectly assuming that all stranded gas produced at oil wells is vented rather than flared.

Inaccurate or inflated emissions estimates are a significant concern, because EPA will need to take into account the cost of controls. Larger methane emissions volumes mean a higher value for the captured and

Continued on next page



Memories
from page 36

And in that moment, in me, he made a conquest for life.

The Spindletop 50th anniversary celebration made it abundantly clear: That watershed event on Jan. 10, 1901, had made the world a different place.

Now, in the little more than a century since it exploded onto the world scene, petroleum and petrochemicals have permeated every aspect of our lives, from our methods of transportation to our most minute everyday needs.

And it all began with that moment on Spindletop Hill, when the world was allowed to imagine that it hosted a virtually unlimited supply of oil, there for the discovery.

The Memories Still Linger

The 100th anniversary of the Lucas Gusher was held Jan. 10, 2001, in Beaumont at Lamar University's Spindletop-Gladys City Museum, just across the road from the old oil field.

At exactly 10:30 am, a towering plume of water gushed through an exact replica of the Hamills' wooden derrick to commemorate that event of a century before, viewed by throngs of spectators and dignitaries, including former U.S. President George H.W. Bush.

A hundred years later, old Spindletop could still draw a crowd.

As for me, my personal mystique of Spindletop has always held strong – and in commemoration of its hundredth anniversary, my colleagues and I were accorded the privilege of writing the history of the discovery.


LUCAS


HAMILL

But my most vivid memory remains the kindness and modesty of one man, a celebrity, a man of the hour who took the time to talk to a 10-year-old pigtailed, freckle-faced girl who had the temerity to approach him.

I'll carry that memory with me for the rest of my life.

Editor's note: Ellen Walker Rienstra is the co-author of several histories and historical articles, including Giant Under the Hill, a history of the 1901 Spindletop oil discovery at Beaumont, Texas, and six articles for the new edition of The Handbook of Texas.

She served as a consultant for the episode on Spindletop in "America: The Story of Us," the 2010 American History series for the History Channel, and, with a colleague, researched and wrote text and photographs for the museum at the University of Texas Lutcher Stark Center for Physical Culture and Sports.

Rienstra currently does research and writing for the Nelda C. and H.J. Lutcher Stark Foundation in Orange, Texas. She is a past president of the Lamar University Alumni Advisory Board and is also a member of the Lamar University Foundation and the Spindletop-Gladys City Boomtown Museum Advisory Board.

Continued from previous page

marketed methane, which can justify requiring more expensive mitigation technology or procedures.

The mitigation technologies that EPA considers are:

- Reduced-emissions (green) completions, which are currently required for gas wells; the technology for oil wells is essentially the same. Green completions may involve the sale, on-site use, flaring or reinjection of completion flow-back gas.

- Flaring (combustion devices), which is standard operating procedure for wells throughout the United States. Both flaring and separating gas and sending it to a sales line are very efficient, removing up to 98 percent of methane.

- Natural gas liquids recovery; this was applied to Bakken wells not connected to natural gas collection infrastructure, and then the results were evaluated by the Energy & Environmental Research Center (EERC) of the University of North Dakota. EERC found the technology of limited economic application.

- Natural gas reinjection to mitigate methane emissions has never been evaluated.

Some reviewers also suggest consideration be given for some regions' lack of infrastructure to send gas to market.

The Bakken is the largest play that has inadequate natural gas gathering infrastructure. In 2014's third quarter, just over 26 percent of natural gas production in the Bakken play was flared, compared to about 40 percent in the fourth quarter of 2011. In other regions wells may produce at pressures lower than the natural gas collection infrastructure, and the use of a compressor to raise the pressure of small volumes of gas enough to flow into collection lines may be uneconomic.

Reviewers also note that the EPA, in its white paper on completions, failed to consider how many states do not allow uncontrolled emissions. This suggests that the EPA is not considering how its regulations might duplicate state regulations.

It also suggests another way the EPA may have overestimated emissions.

Mexico Invites Seismic Exploration

By BRIAN ERVIN, EXPLORER Assistant Managing Editor

While the rest of the world of seismic exploration is scaling down in response to the current trend of depressed oil prices, the government of Mexico is beckoning to all comers and, so far, they seem to be answering.

"The good news is that we just opened this new industry last week and we've already received applications from many important seismic companies," Mexico's National Hydrocarbon Commission (CNH) President Juan Carlos Zepeda told the EXPLORER in a recent interview.

At the time of this writing, nine major companies had applied for seismic permits in Mexico, he said:

- GX Technology.
- Schlumberger.
- Dolphin Geophysical.
- TGS.
- PGS.
- CGG.
- Spectrum ASA.
- SEITEL.
- Geoprocesados.

"Here in Mexico, we went through an important reform last year in terms of opening the industry to private investment," said Zepeda, referring to the historic constitutional reforms passed into law in late 2013, effectively ending the 75-year-old state monopoly on Mexico's abundant oil and gas resources.

"This opening includes seismic activity – we just opened up our industry to develop an international seismic industry," he added.

In late January, CNH published the guidelines and regulations by which seismic permits will be granted, which


ZEPEDA

> "We are expecting the seismic information in Mexico will more than double in three or four years."

Zepeda explained are the product of a diligent public consultation process with the international industry in general and the International Association of Geophysical Contractors in particular.

"So we received plenty of comments and reviews from international companies, including the (IAGC), and those comments were included as part of our regulations. That's why we're confident our guidelines and regulations are consistent with international practices," he said.

"So we are going to be granting permits to any exploration seismic company interested in performing and acquiring information in Mexico," he added, "and by means of this permit, we will be granting a 12-year commercial rights period by which you will use that period to sell the information."

Offshore Interest

Zepeda said a decision on the specific locations and acreage available for exploration and production is "still pending," but he indicated they would be evaluated on a case-by-case basis.

"They first present their credentials, and then we qualify them," he said. "We make a prequalification based on their technical capabilities, and afterwards, they will present the actual seismic project."

So far, though, Zepeda said most of the interest is offshore, which he anticipates will characterize most seismic activity.

"What different companies have told us and shown us is that they're going to shoot seismic offshore in the Gulf of Mexico and they will cover pretty much the whole Gulf of Mexico on the Mexican side," he said. "They're covering pretty much the whole Mexican side of the Gulf of Mexico with 2-D seismic and some 3-D seismic.

"But, of course," he continued, "as soon as we receive those technical proposals and projects and get approval from CNH, we will make that information public."

Low Prices, No Problem

While other parts of the world are seeing a sluggish seismic industry owing to plummeting oil prices, Zepeda said that's not a concern in Mexico.

"The prices are not a problem," he said. "When you shoot seismic, the acquisition of the information takes around three years. So these companies don't have a short-term vision. They're looking in the long-term," he explained. "This is information that's going to support investment decisions in four or five years. So they're not looking at the short-term price."

Seismic prospects aside, not everyone shares Zepeda's optimistic appraisal of the current oil market, nor Mexico's place within it.

In a recent teleconference with investors, Occidental Petroleum CEO Steve Chazen described the financial terms offered by Mexico as "ridiculous," especially in light of today's prices.

"If you look at some of the other places, I won't say where, but look at some of the other places where intrinsically the asset might work at $20 a barrel or something like that, but if you lay the contract over it doesn't really work at today's prices. And I think that's the issue in Mexico," he said. "While the asset may be attractive and you can get a lot of – if you had 100 percent of it would be something that would work pretty well, but they have taken a pretty aggressive view about the contract terms.

"I think we would rather frankly put the money into the CO_2 projects in the United States where we have low royalties and in fact in some cases we owe the royalties than to fool around with some ridiculous contract in hopes it gets better over time," he added.

Zepeda didn't appear to put much

See **Mexico**, page 43

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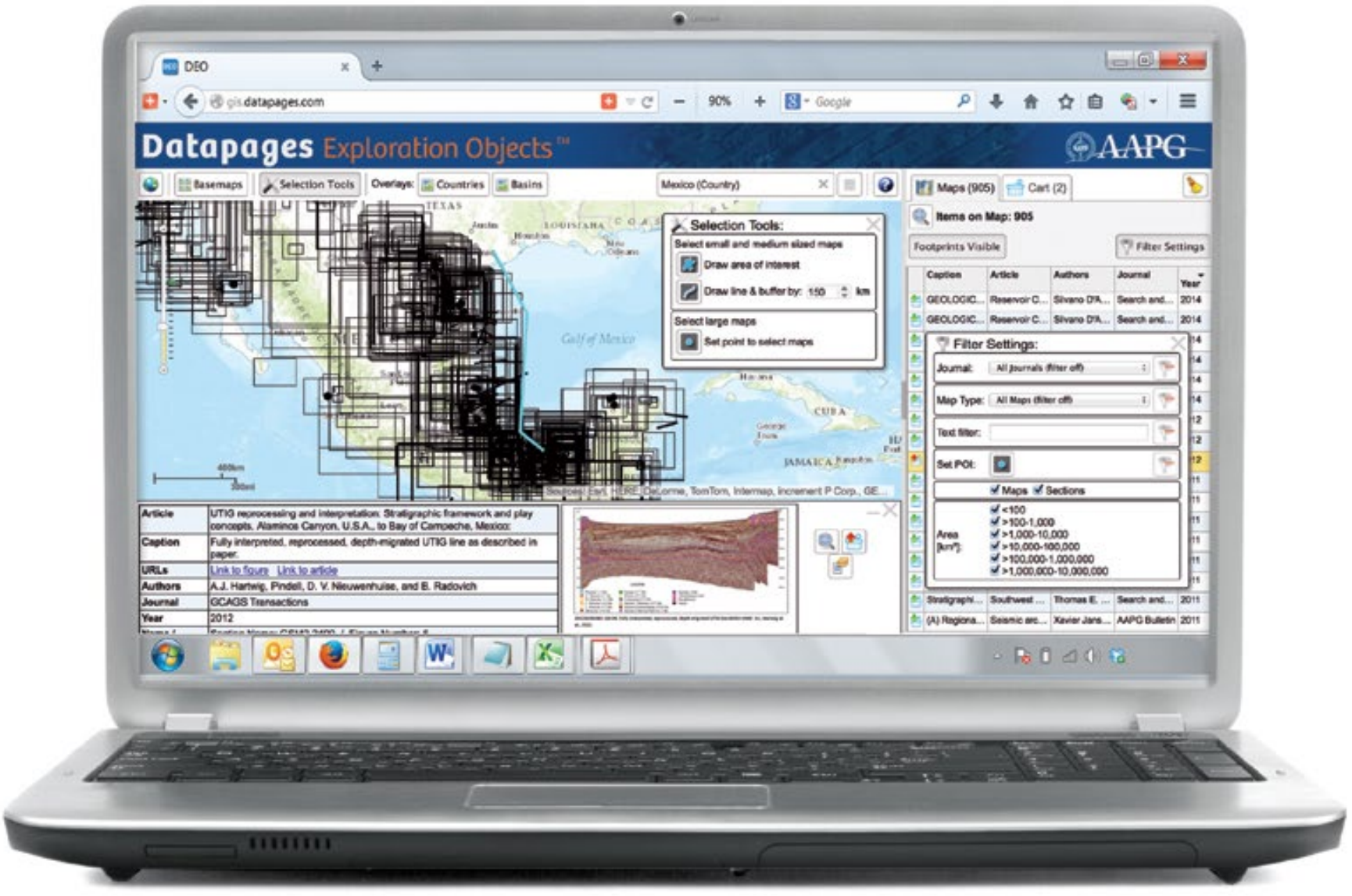

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Regions and Sections is a regular column in the EXPLORER offering news for and about AAPG's six international Regions and six domestic Sections. This month's column is written by Clinton Tippett, who represents the Canada Region on the AAPG Advisory Council. The opinions expressed are personal and do not represent the positions of his employers and other associations.

Introducing the 2015 Southwest Section of the AAPG Annual Convention

AAPG
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Evaluating the Past, Exploring the Future

April 11–14, 2015

Wichita Falls, Texas

❖ **Field Trip – Saturday, April 11th**

The Wichita Mountains, Oklahoma, A tour of Eocambrian rifting and Permian erosion
- Led by Dr. Jonathan Price – Midwestern State University
- Exploring the intense magmatism and subsequent deformation associated with the Southern Oklahoma Aulacogen
- Lunch at the famous Meers Store

❖ **Annual SWS-AAPG Short Course – Sunday, April 12th**

Borehole Imaging: From Acquisition to Interpretation
- Presented by Valentina Vallega – Senior Borehole Geologist, Schlumberger
- Open to geologists, reservoir engineers, team managers, or those who work with borehole imaging data through open hole logging programs

❖ **Icebreaker – Sunday Evening, April 12th**

The traditional icebreaker kicks off the convention!
- Hear the smooth sounds of Wichita Falls blues legends The Mike O'Neill Band
- Visit with our exhibitors while reconnecting with old friends and making new contacts
- Feast on shrimp, tenderloins, and heavy hors d'oeuvres

*Admission with name badge; cash bar

❖ **Technical and Poster Presentations – April 13th & 14th**

- Unconventional resource plays in Texas and the U.S.
- Papers and posters covering frontier exploration areas and alternative exploration techniques
- Presenters interested in participating may contact Nic Brissette at nbrissette@gunnoil.com

❖ **"Southern Hospitality" – Monday Evening, April 13th**

Bob and Ann Osborne open their locally-famous estate for an evening of socializing and southern hospitality. Their home, built in 1935 by local drilling legend Red Dillard, was originally landscaped in 1949 by international architect James Fry of Paris, France. Most recently, Georgia landscape architect Phillip Watson refined the rose gardens to accentuate the sprawling lawns.
- Enjoy a rib dinner prepared by the Wichita Falls Mavericks
- Afterwards, board the trolley for a tour of the Country Club Estates presented by a local historian
- Complete your evening listening to the cowboy crooners Prairie Moon perform

*Shuttle service will be provided to and from local hotels

For more information on the convention, go to:
http://www.ntgeologicalsociety.org/2015-southwest-section-of-aapg-convention/

Photo courtesy of Clinton R. Tippett

Basal Mississippian organic-rich strata of the Bakken-correlative Exshaw Formation lie conformably on Upper Devonian strata of the Palliser Formation in the Front Ranges of the Rocky Mountains at Crowsnest Pass, southwestern Alberta.

Keeping Our Cool – A Perspective From the Great White North

By CLINTON R. TIPPETT, AAPG Advisory Council, Canada Region

The current collapse of oil prices and the continuing downward pressure on natural gas prices have been a double whammy for the Canadian oil patch.

At least while oil was attractive, players could be liquids-focused; but now, that once-safe haven has been eliminated. The repercussions of this downturn here are now rippling through industry, governments and society at large.

TIPPETT

In the face of much-reduced cash flows, companies are reshaping their capital budgets, with the viability of some outfits now in question.

Initial indications are that manpower levels will be the next target. And as the annual report cycle progresses, the reassessment of reserves will not be a pretty exercise. Our service sector, always on the leading edge of field activity levels, can be expected to bear the initial brunt of these changes.

Strangely, this situation appears to have been forecast by only a handful of people.

But hey! Haven't we seen this show before?

In the early 1980s, increasing supply driven by high prices combined with a slowing of demand led to a similar opening of the taps in the Middle East in an effort to regain market share. This triggered a slippage in oil prices, the effects of which were compounded in Canada by a deteriorating business climate and an interventionist federal government program of taxes and policies.

The downside of that situation took half a decade to sort itself out.

We seem to be on the cusp of a similar predicament today, although events have unfolded in a much more rapid fashion in the current unregulated marketplace.

Now What?

The question in Canada, as elsewhere, is "How should the industry react?"

Some financial measures by companies to protect themselves are a given, but on the subject of preparing for the future, there is considerable divergence.

A few players are upbeat, hoping for a quick turnaround and therefore will not resort to drastic measures – at least not yet.

Others are of the doom-and-gloom mindset, perhaps remembering previous downturns and believing this correction will take several years to play out and harsh measures are therefore in order.

Perhaps the silent majority hope there is a middle ground in which new technological breakthroughs combined with a reduced cost structure will provide a salvation.

Are there any factors in the current context that make this downturn fundamentally different from previous ones?

The answer is "yes."

High-cost unconventional production of both oil and gas is far more important across North America right now than at any time in the past. Oil and gas in shales, tight sandstones and tight carbonates as well as oil sands have been in the limelight for the last decade. We have seen flush production from both oil and gas commodity streams. Many have pointed to large production volumes from this group of assets as at least a partial trigger for the price collapses.

So how will unconventional resource plays fare in a low price environment?

First, we don't have a good sense for where these plays sit in terms of their creaming curves; maybe they would have peaked already and become stable at best.

Also, unconventional production is generally high cost and requires continual re-investment in new wells, given the rapid decline in production rates for individual producers.

So presumably, if unconventional plays are now both uneconomic and starved of capital, their production will dwindle and we will have to contend with either shortages or increased imports.

One of the attractions of these sorts of plays has been the idea that they are a sort of "manufacturing" operation that can be turned on and off as a function of prices. The validity of this model is questionable, however, if the structure of the industry – be it infrastructure, services or people – is damaged in a prolonged downturn.

Continued on next page

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And let's not forget about the societal opposition to many well stimulation and completion methods – for example, opposition to the use of hydraulic fracturing in some of the new prospective regions in Canada and the United States.

For many players, it may be "once burned, twice shy."

One sphere of activity that has been ignored for this last decade, at least in onshore North America, is the conventional prospect world.

Should we be considering a renewal of activity in traditional fairways?

Virtually all of the interest in conventional plays dwindled in the face of the huge volumes attributed to unconventional plays. But if the latter stumble due to reduced investment, perhaps our trusty old plays, combined with the rejuvenation of older fields, can come to the rescue.

Don't Overcorrect

North America has a voracious appetite for oil and natural gas that may even increase in a lower price environment. Today's hydrocarbon glut could turn into tomorrow's shortfall, if production and reserve replacement start to slip.

As unconventional production falters, our industry may be called upon to re-enter those conventional play fairways that have been ignored in recent years.

If that happens, where will we find the skilled workforce to do this if experienced staffs have been laid off?

Fully functional integrated teams cannot be re-created overnight, and rash cutbacks could easily be counterproductive.

The challenge for the Canadian industry will be to try to anticipate how this complicated interaction of supply and demand will work itself out, and to be ready to remobilize when the time is right.

If we allow our exploration and production capabilities to be degraded in a moment of crisis, we will not be able to fulfill this mission. Farsighted management in our industry is essential, on both sides of the border.

We need to look at how recent advances in technology and successful ventures elsewhere in the world can help us profitably re-enter some of our old stomping grounds – whether that be in western Canada or the frontiers.

Let's make sure that we keep our powder dry for the next chapter in this unfolding drama.

(Editor's note: Clint Tippett is a retired petroleum geologist and president of the Calgary-based Petroleum History Society.)

Mexico
from page 40

weight into Chazon's criticisms.

"We are having a lot of interest from different oil companies," he told the EXPLORER.

"We already have 23 applications from major international oil companies taking part in the first bidding round in Mexico. So, we're getting a lot of interest and we're happy about that, especially considering the drop in oil prices," he added.

However, Zepeda also added that the current financial terms are hardly set in stone.

"We are open to receive all kinds of comments regarding the contract in all of its aspects, and the Mexican government will be making the required adjustments," he said. "So we are taking very seriously any comments provided by the industry. I encourage the industry to send CNH their comments regarding any aspect of the contracts and the bidding guidelines."

Zepeda said comments can be made through the CNH website.

For now, though, with the country now open for seismic exploration, Zepeda said the amount of data on Mexico's hydrocarbon resources will increase dramatically.

"Regarding these new regulations for granting the seismic permit," he said, "the impact that this will have on Mexico and the industry, and from what I have seen, from the plans that seismic companies are considering, we are expecting the seismic information in Mexico will more than double in three or four years."

Membership Offers Savings

By VICKI BEIGHLE, AAPG Member Services Manager

A reminder to all AAPG members: Those who meet qualifications and/or eligibility requirements can save up to 75 percent on annual dues.

AAPG offers a graduated dues structure, which is based on the member's ability to pay, according to their annual Personal Gross Income (PGI):

- Level 1 – Full dues for all individuals earning $50,000 PGI is $105 per year.
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For more information contact us at (918) 584-2555, or email Members@aapg.org.

A Delicate Balance: Seeing Faults More Clearly

By SATINDER CHOPRA and KURT J. MARFURT

Spectral decomposition of seismic data helps in the analysis of subtle stratigraphic plays and fractured reservoirs.

The different methods used for decomposing the seismic data into individual frequency components within the seismic data bandwidth serve to transform the seismic data from the time domain to the frequency domain – and generate the spectral magnitude and phase components at every time-frequency sample.

The spectral amplitude and phase components are analyzed at different frequencies, which means essentially interpreting the subsurface stratigraphic features at different scales.

More recently, another important attribute that could be generated during spectral decomposition has been introduced, and is referred to as the voice component at every time-frequency component.

(For more details of this attribute, refer to the EXPLORER's November 2014 Geophysical Corner.)

The voice component at any individual frequency, say 30 Hz, is obtained by cross-correlating the seismic amplitude data with the mother wavelet (such as the Morlet wavelet), centered at 30 Hz with a frequency width of 30 Hz on either side. Thus the bandwidth of the voice component increases as the frequencies increase from the lower end to the higher end of the bandwidth.

One may consider the process to be equivalent to applying a narrow band pass filter centered at 30 Hz to the data, but having some narrow bandwidth around on both sides.

We show an example of a voice component section in figure 1, along with its amplitude spectrum.

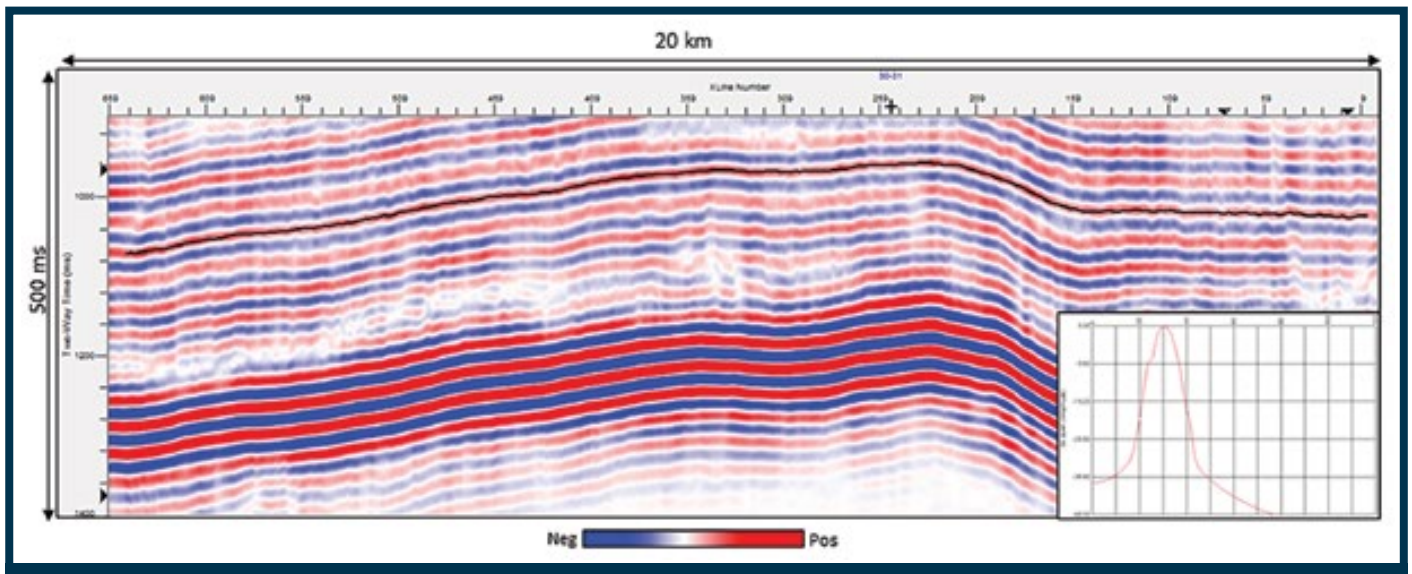


Figure 1 – An inline from the 30 Hz voice component after spectral decomposition with spectral balancing and its amplitude spectrum. Notice the frequency width on both sides of the amplitude maxima seen at 30 Hz.


CHOPRA

Spectral balancing of seismic data, when performed in an amplitude-friendly way, leads to higher frequency content.


MARFURT

* * *

Such voice components offer more information that could be processed and interpreted.

We have focused on interpretational objectives of spectral decomposition in our earlier articles in the Geophysical Corner (December 2013 and March 2014) and demonstrated our examples pertaining to channels and other stratigraphic features. In this article our examples focus on faults and fractures.

In figure 2 we show a segment of a seismic section from a 3-D seismic volume from northern-central Alberta, Canada.

Continued on next page

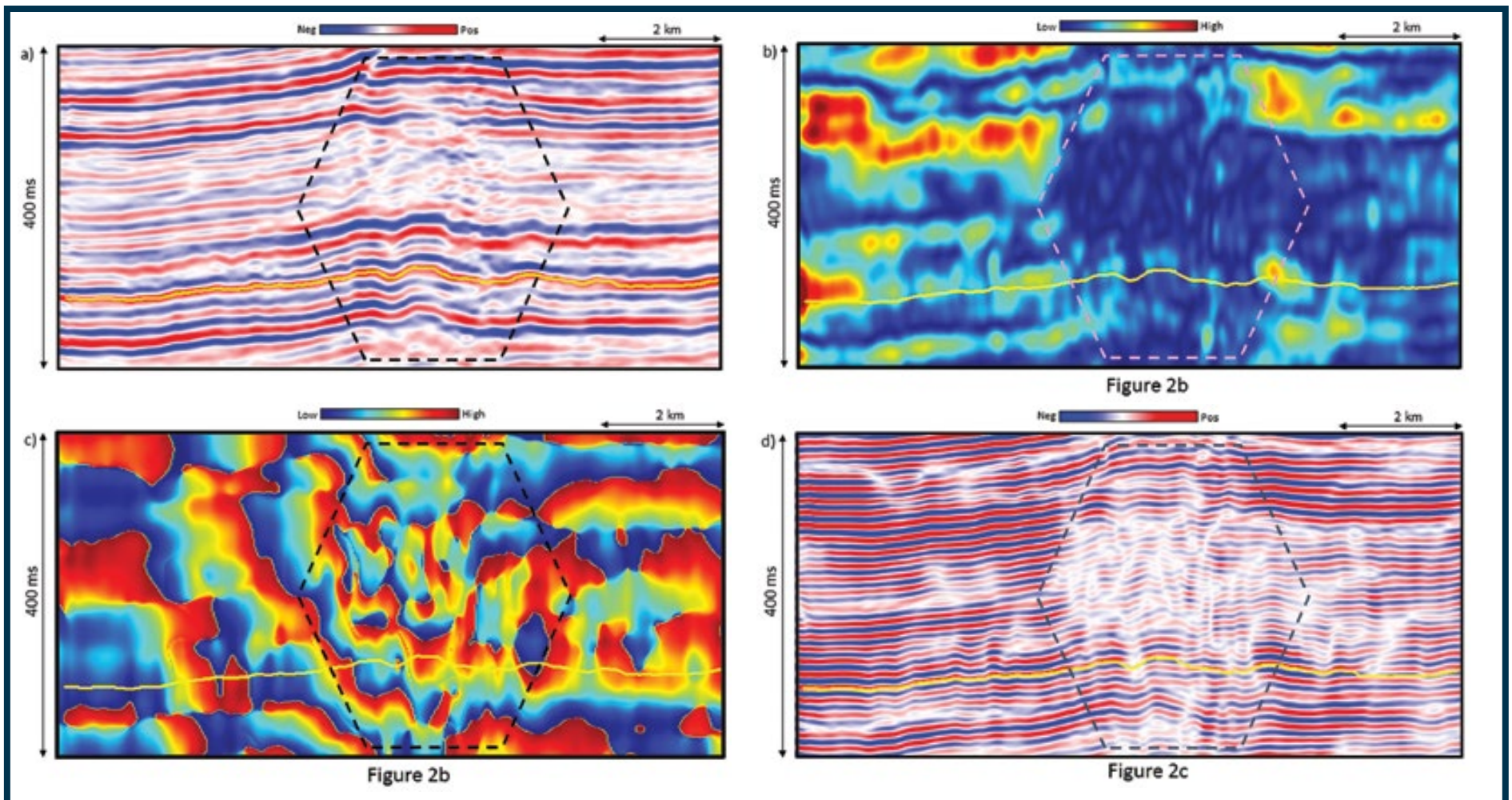


Figure 2 – (a) Segment of an inline through the input 3-D seismic amplitude and corresponding 65 Hz (b) spectral magnitude, (c) spectral phase and (d) spectra voice volumes. Notice the vertical discontinuities in the highlighted portion are poorly seen in the original broadband data; are not seen in the spectral magnitude component; but are clearly seen in the spectral phase and voice components. The voice component has the advantage in that it can easily be interpreted and processed (e.g. using coherence) as one would the original seismic amplitude data.

The Geophysical Corner is a regular column in the EXPLORER, edited by Satinder Chopra, chief geophysicist for Arcis Seismic Solutions, Calgary, Canada, and a past AAPG-SEG Joint Distinguished Lecturer. This month's column deals with spectral decomposition and spectral balancing of seismic data.

Continued from previous page

The equivalent sections from the spectral magnitude, phase component, and the voice component at 65 Hz are shown in figures 2b, c and d respectively.

Notice that the vertical discontinuity information is not clearly seen on the spectral magnitude, but rather on the phase component. The voice component combines both attributes and nicely delineates the discontinuities.

This observation could be exploited to our advantage by either interpreting the discontinuity information as such, or by running a discontinuity attribute, such as coherence, on the voice component volume.

Traditionally, the spectral component magnitudes at different dominant frequencies have been utilized for obtaining detailed perspectives on stratigraphic objectives. As an example, the thickness of a channel is correlated with the spectral magnitude.

More detailed information on seismic geomorphology can be gained by visualizing data at specific frequencies, or combining data with different frequencies using RGB color schemes.

Another conclusion that one can have is that if the input data are spectrally balanced, or if its frequency bandwidth is somehow extended, the resulting volumes could lead to higher discontinuity detail.

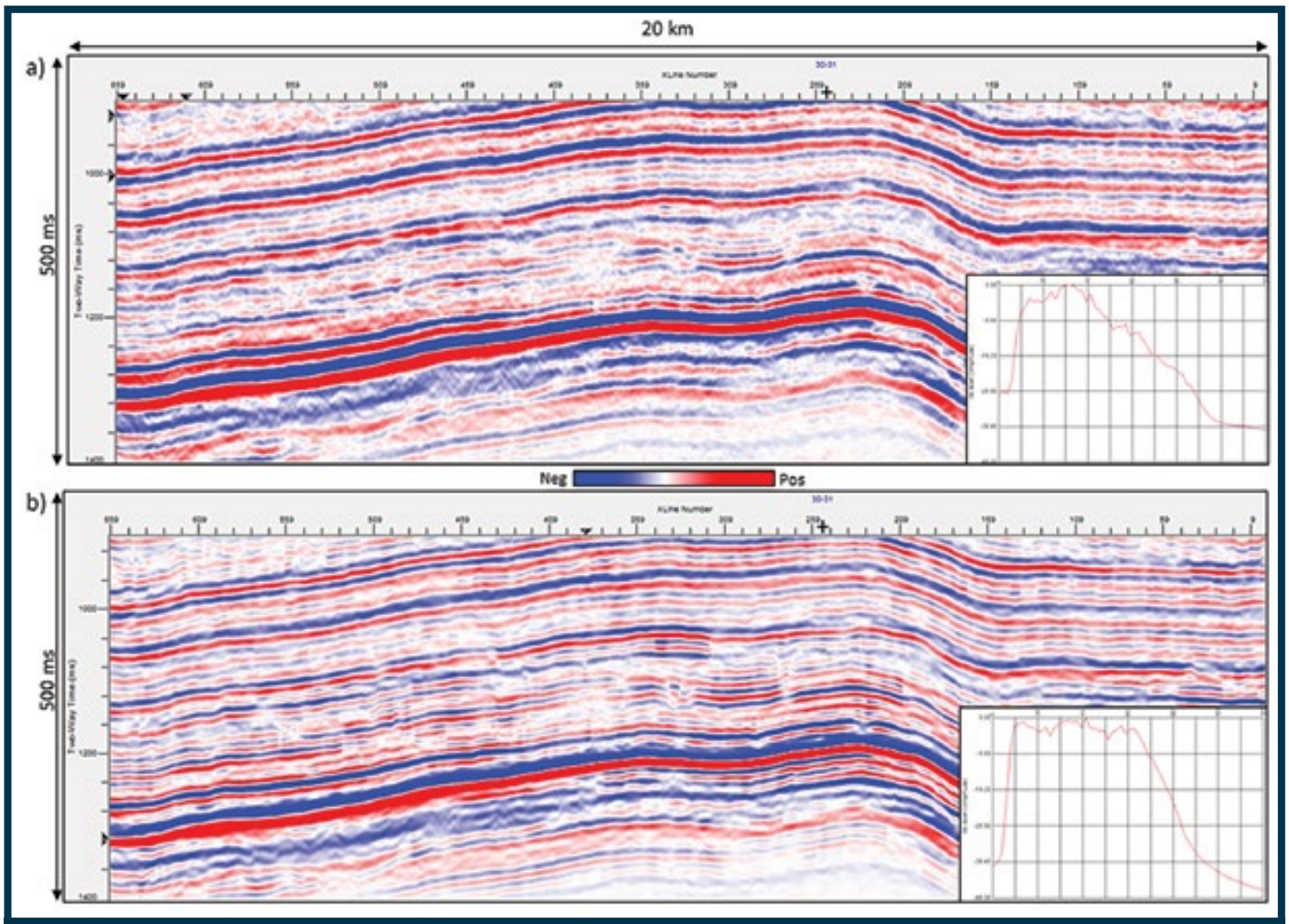


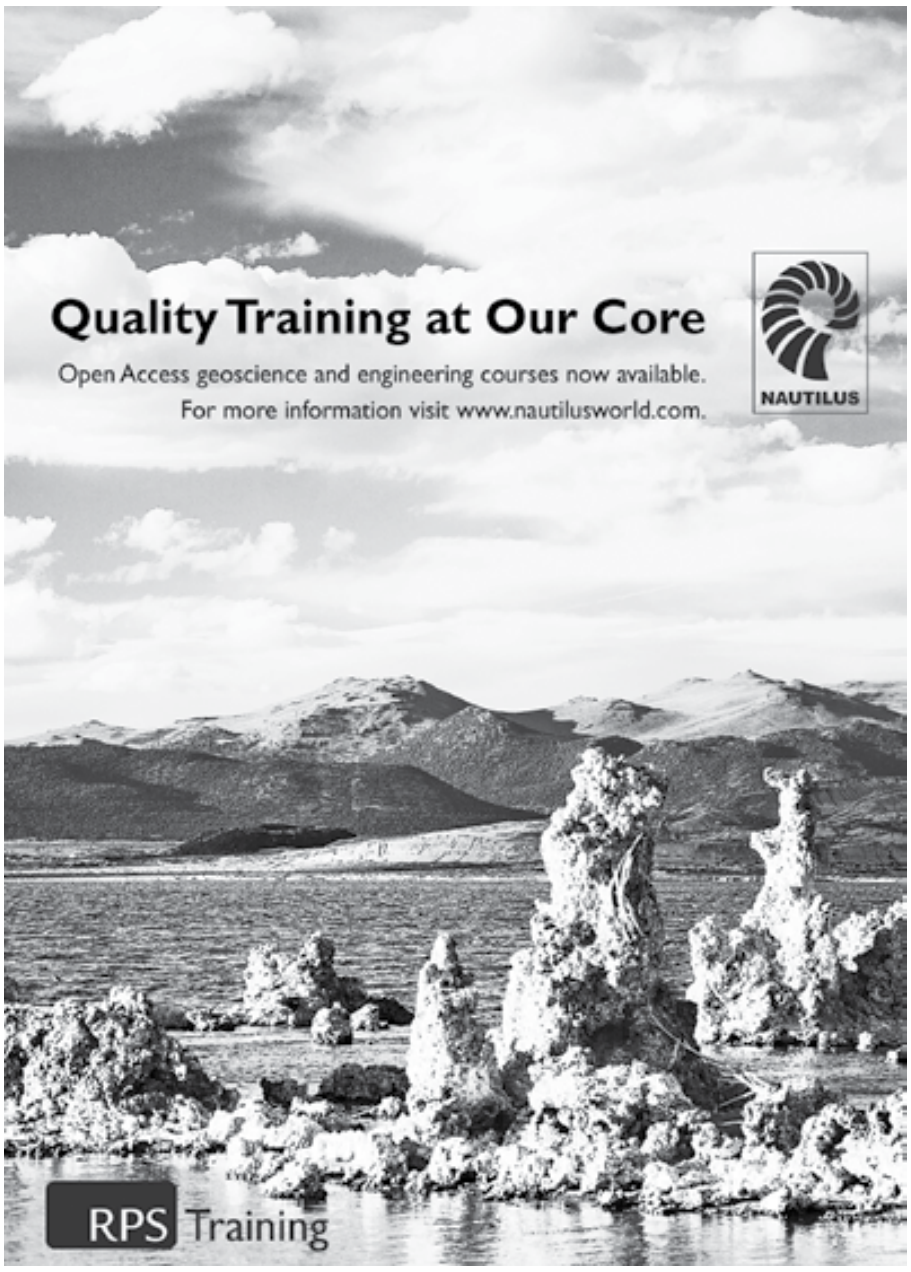
Figure 3 – An inline from the (a) input seismic data and (b) input seismic data with spectral balancing. The amplitude spectra for both the datasets are shown in the insets to the lower right.

We focus on this aspect in this article.

In the May 2014 Geophysical Corner, Marfurt and Matos described an amplitude-friendly method for spectrally balancing the seismic data. In this method, the data are first decomposed into time frequency spectral

See **Spectral Magnitude**, page 47

"ProTracks" is an ongoing feature of the EXPLORER, offering news and information pertinent to getting started or getting better in your career.



PROTRACKS

Members of Aberdeen's YP chapter bonded and learned during a field trip of Scotland's dramatic east coast by visiting localities in St. Cyrus and Stonehaven.

Continued development

YPs Need Fieldwork

By SAMUEL McLAY, Europe Region YP Lead

Fieldwork forms a large part of many geologists' undergraduate and postgraduate studies. Its prominence generally decreases, however, when students make the transition from academia to industry and become a Young Professional (YP).

Exposures in outcrop at scales comparable to that of seismic data enable better interpretations, as we can draw upon realistic geological architectures that can subsequently be applied to subsurface reservoirs. The field environment encourages critical thinking and often inspires discussion regarding alternative interpretations.

McLAY

In addition to being good physical exercise, it is the excitement of discovery that attracts many geologists to the field; another piece of the geologic puzzle could be waiting just beyond the next elevation or obscured by thick vegetation.

* * *

YP groups in Europe have taken the initiative to offer fieldwork outings to members during weekends.

These trips have been made possible by the enthusiasm of numerous committed geologists who have dedicated their spare time to rocks.

▸ Last year, Aberdeen's YP chapter took in the east coast of Scotland's dramatic scenery by visiting localities in St. Cyrus and Stonehaven.

The trip was led by professor and AAPG member Adrian Hartley of the University of Aberdeen, and generously funded by Chevron and Maersk.

Exposures at St. Cyrus record the lava-sediment interactions occurring during formation of the Midland Valley basin. Sediment rafts within lavas and locally present pepperites demonstrate the extensive influence volcanism had on the geology.

Discussions at this locality focused on how lessons learned from these outcrops could help YPs understand the intrusive and extrusive volcanic rocks of the Faroe-Shetland Basin and their interaction with the petroleum system. Stonehaven possesses an excellent exposure of the Highland Boundary fault – and despite its historical significance, the relative timing of fault motion is still debated.

▸ A group of YPs based in The Hague visited Belgium and southern parts of Netherlands to study some of the stunning exposures in mainland Europe.

Fieldwork in the Saeftinge area involved using modern analogues to investigate the small-scale elements of fluvial and deltaic systems as well as examining aeolian sandstones from the Pleistocene era.

The group travelled to Kouterhof Hoegaarden to study world-class examples of petrified wood, which were fossilized in the area during the Eocene Thermal Maximum – and they also wisely incorporated a visit to the world famous Hoegaarden brewery!

▸ A virtual field trip recently was tested via the screening of an AAPG e-Symposium presented by Garry F. Hayes. The tour took attendees on a spectacular visual journey through geological landmarks in the United States from the comfort of a conference room in Europe.

Specifically, the trip spanned the glitter of Las Vegas to the towering spires of Bryce Canyon, and provided a remarkably detailed history of the North American continent from the Early Proterozoic to Holocene times.

The virtual field trip concept was relatively new for most attendees, but overall the event was a decided success.

* * *

The importance of fieldwork cannot be understated for the continued development of YPs. Low oil prices will make justification for field excursions more difficult, and the geologist's "jolly" may be considered a non-essential expenditure by decision makers.

However, I encourage all AAPG members to champion the geologist's rightful need for field-based learning during these times of industry austerity.

Ultimately, the study of outcrops allows for a sound understanding of geological concepts to be developed and applied in the office – and thereby enables us to make better business decisions. E

Spectral Magnitude

from page 45

components. The spectral magnitude is averaged over all the traces in the data volume spatially and in the given time window, which yields a smoothed average spectrum.

* * *

Next, the peak of the average power spectrum also is computed. Both the average spectral magnitude and the peak of the average power spectrum are used to design a single time-varying spectral balancing operator that is applied to each and every trace in the data.

As a single scalar is applied to the data, the process is considered as being amplitude friendly.

Figure 3 shows segments of a seismic section and its equivalent section after spectral balancing. The individual amplitude spectral before and after are shown as insets.

Notice that after spectral balancing the seismic section shows higher frequency content and the amplitude spectra is flattened.

Encouraged with the higher frequency content of the data, we run Energy Ratio coherence on the input data as well as the spectrally balanced version of the data. The results are shown in figures 4a, b and 5a, b, where we notice the better definition of the NNW-SSE faults as well as the faults/fractures in the E-W direction on the coherence run on spectrally balanced version.

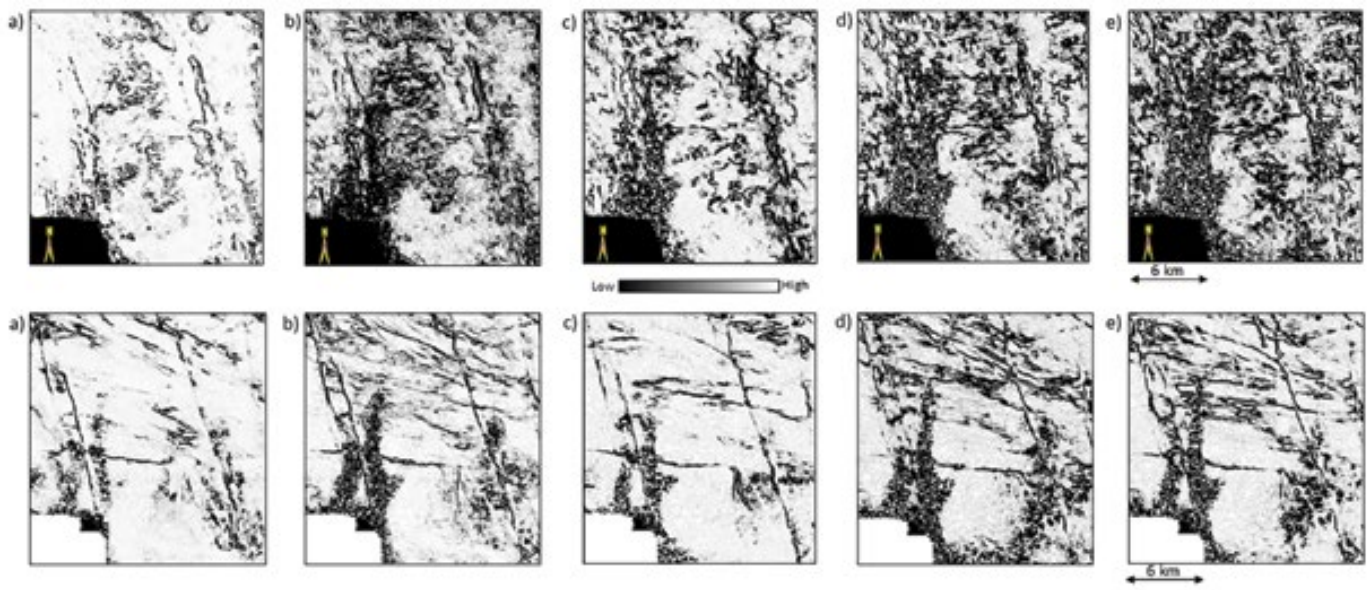


Figure 4 (top row) – Stratal slices 40 ms above the horizon close to 1700ms, from the coherence attribute run on (a) input seismic data volume, (b) the input seismic volume with spectral enhancement, (c) voice component at 65 Hz, (d) voice component at 75 Hz and (e) voice component at 85 Hz.

Figure 5 (bottom row) – Time slices at 1322 ms, from the coherence attribute run on (a) input seismic data volume, (b) the input seismic volume with spectral enhancement, (c) voice component at 65 Hz, (d) voice component at 75 Hz and (e) voice component at 85 Hz.

Finally, we run the spectral decomposition on spectrally balanced version of the input seismic data, and put the voice components through to Energy Ratio coherence computation.

In figures 4c, d, e and 5c, d, e we show time slices and horizon slices at different levels from the 65, 75 and 85 Hz frequency volumes.

Notice the clarity in the definition of the discontinuities on both sets of displays. Such data lead to better interpretation of the discontinuities than carrying out the same exercise of the input data.

* * *

The conclusions that one can draw from the foregoing examples is that spectral balancing of seismic data, when performed in an amplitude-friendly way, leads to higher frequency content – which in turn exhibits detailed definition of faults and fractures.

Such discontinuity information can be interpreted better on coherence displays in the zone of interest. Coherence attribute computation performed on spectral decomposition after spectral balancing, or on the voice components at higher frequencies yields higher detail with regard to the faults and fractures.

(Editor's note: AAPG member Kurt J. Marfurt is the Frank and Henrietta Schultz Chair and Professor of Geophysics at the ConocoPhillips School of Geology and Geophysics, University of Oklahoma, Norman, Okla.)

Colorado Earth Science Teacher Named TOTY

By SUSIE MOORE, Communications Project Specialist

Veteran geosciences teacher Jacqueline "Jackie" Bath of Littleton, Colo., a freshman earth sciences teacher at ThunderRidge High School in Highlands Ranch, Colo., has been named the 2015 AAPG Foundation's Teacher of the Year.

Bath, who also teaches geology as an elective to high school juniors and seniors, has been teaching at ThunderRidge for 18 years – and coincidentally, in receiving the honor becomes the 18th recipient.

The annual TOTY honor bestows a $6,000 prize, which will be split between Bath and ThunderRidge High – $3,000 to the school for educational uses under Bath's supervision, and to Bath $3,000 for her personal use.

She also will receive an expense-paid trip to the AAPG Annual Convention and Exhibition in Denver, May 31-June 3, where she will be presented the award at the All-Convention Luncheon.

Of winning the award, Bath said she was excited and honored.

"To be recognized as AAPG's Teacher of the Year is truly humbling and I am grateful.

"My career, as an earth science educator has been a journey," Bath said. "My passion for geology and the geosciences provides inspiration to develop activities that actively engage students in meaningful ways."

Bath's students are "actively engaged in learning and applying concepts" through a collaborative classroom environment. She is revered by her colleagues as "innovative," "engaging" and "inspiring."

Reading through her class curriculum and letters of recommendation provides a clue as to why she was nominated: from podcast lectures and interactive tutorials, to simulations, labs and direct exposure to local, regional and global issues, Bath creates a *sort of* geological utopia, in which students are encouraged to immerse themselves and make real-world decisions.

A feature story on Bath and her teaching experiences and philosophies will be included in the May EXPLORER.


BATH

Bath was one of six TOTY finalists, competing for the prize with teachers who had won top teaching honors in each of the six AAPG Sections. The finalists were all submitted to a panel of national judges, led by committee chair Laura Zahm.

The five semi-finalists will receive $500 awards from the AAPG Foundation. They are:

- **Sue Boucher** (Eastern Section finalist).
- **Jennifer Reyes** (Gulf Coast Section finalist).
- **Katherine Hoover** (Southwest Section finalist).
- **Shannon Chatwin** (Midcontinent Section finalist).
- **Stephan Kiouses** (Pacific Section finalist).

Foundation Contributions for January 2014

General Fund
Rodrigo Bastidas
Don W. Beauchamp
In memory of Robert F. Walters
Dan A. Hughes
Lacie B. Knight
Jon F. Messenger
Jeffrey A. Nunn
John and Marilyn Palmer
In memory of Richard A. Edmund
Carolina R. Duenas
Mark M. Roth
Harley K. Sayles
David R. Swenson
Dominic K.F. Yap

Digital Products Fund
Louisiana State University
Jeffrey A. Nunn

Universidad Nacional de Colombia
Rodrigo Bastidas

University of Houston
Carolina R. Duenas

University of Oklahoma
Rodrigo Bastidas
Wichita State University
Harley K. Sayles

Education Fund
John W. Raine III
Joy M. Roth

Grants-in-Aid Fund
Edward B. Picou Jr. Named Grant
Jeffrey A. Nunn
Paul H. Dudley Jr.
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Chuanbo Shen

Harry and Joy Jamison Named Grant
Dan and Jeanne Jamison
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Mark D. Sonnenfeld

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William E. Crain

Imperial Barrel Award Fund
Gretchen M. Gillis
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Military Veterans Scholarship Fund
Leonard S. Fowler
Merlin Dean and Nancy E. Kleinkopf
Harold W. Knudsen
John P. and Laura C. Moffitt
Mark D. Sonnenfeld
M. Ray Thomasson and Merrill Shields
In memory of Tommy Thompson

Newly Released Publications Fund
Kansas State University
Kenneth J. Macho

E.F. Reid Scouting Fund
Paul H. Dudley Jr.
In honor of Harry Jamison

L. Austin Weeks Undergraduate Grant Fund
Borden R. Putnam III

The monthly list of AAPG Foundation contributions is based on information provided by the AAPG Foundation office.

Military Veterans Scholarship Program Launch

Thanks to the many generous supporters who contributed to the U.S. Military Veterans Scholarship Program in late 2014, the AAPG Foundation has met and exceeded its initial threshold goal of $500,000.

Thanks to this generous support, applications for the MVSP are now open on the Foundation website. The first scholarship awards are expected to be announced this summer.

The MVSP program encourages applications from both active U.S. military service members (including National Guard and Reserve), or veteran members separated from active military service who have been honorably discharged and are entering or re-entering a post-secondary undergraduate program in a field of geoscience – either full-time or part-time – at a four-year accredited college or university.

Scholarship awards range from $2,000-$4,000.

For more information visit the Foundation website, at foundation.aapg.org.

Record-Setting Field Ready for IBA Season

By BARRY FRIEDMAN, EXPLORER Correspondent

The global field has been set for the largest AAPG/AAPG Foundation Imperial Barrel Award competition in the event's history, with contests set to start this month around the world.

The 2015 IBA has attracted 140 teams from nearly 40 countries, representing all of AAPG's Regions and Sections.

The IBA is an annual prospective basin evaluation competition for geoscience graduate students who compete as teams to win scholarship funds for their geoscience departments – plus a lot of recognition and career-enhancing status for themselves by being part of the program.

Each year, university teams analyze a dataset (geology, geophysics, land, production, infrastructure and other relevant materials) for nearly two months in preparation for the semi-final competitions against other teams in their respective Regions or Sections.

The 12 winning teams from this month's events will go on to compete in the finals competition for the Imperial Barrel Award, which will take place May 29-31, just prior to the AAPG Annual Convention and Exhibition in Denver.

The winning team will be announced in a special awards program that is open to all at 3 p.m. Sunday, as a lead-in to the ACE opening session.

The 2014 IBA was won by the University of Louisiana at Lafayette. In winning, the school became the first in the event's history to become a two-time winner of the top prize, its first win coming in 2012.

The school is once again a part of this year's competition, and will compete against 10 other teams for the right to represent the Gulf Coast Section in Denver.

Tough Times

While IBA is universally applauded as a wonderful opportunity for participating students to gain real-world experience in collaborative work – and to show their efforts to industry experts – this year's competition, like so much of the industry's activities, will be held under and during a dark economic cloud.

It is a trying time. And even with the support of the AAPG Foundation, industry support and sponsorship remain crucial to the IBA's viability.

"The biggest impact on the program this year is the rapid decline in the price of oil and the consequent belt tightening in industry," said AAPG member Charles A. "Chuck" Caughey, a senior adviser with Noble Energy and co-chair with David Cook of the IBA Committee.

That "current economic condition" translates into a more difficult environment in which to obtain the sponsorship required to run an educational program/competition of this nature and scope.

"Many of our loyal sponsors have been unable to contribute this year due to reductions in discretionary spending," Caughey concedes.

As such, the IBA has had to make institutional changes this year to ensure not just fiscal responsibility, but also survival of the program itself.

"In response to the financial situation, a number of measures have been implemented," Cook said, including conducting three of the Regional semi-finals as virtual competitions.

Likewise, the Europe Region, too, has seen a significant cutback in its operation.

"Limited acceptance of applications to the first 20 universities had to be instituted," Cook said, "with the remaining schools encouraged to seek local funding.

"Two universities were able to find sponsorship and will take part in the competition," he added. "Unfortunately this leaves eight universities unable to participate."

Specifically, the economic tightening across the industry means that the datasets on which the schools and students work and are ultimately judged – in other words, the IBAs most integral part – must constantly change.

"We currently have nine active datasets," Cook said. "Universities do not receive the same dataset twice, therefore the IBA Committee is actively seeking new well and seismic datasets for future use.

"Without new datasets," he added, "we will not be able to run the competition in its present form."

Fundraising continues, both Caughey and Cook said, and the committee remains committed to doing all it can to provide a real-world, career-development experience for the students who participate.

Commentary

Disruptive Innovations

By JEFF ALDRICH

Last year I had the opportunity to begin teaching again, and in doing so I asked every class to predict the chance that oil would fall below $100 a barrel and the chance it would fall below $50 a barrel.

Through August nearly all of the class participants under the age of 50 said that there was "very little" to "no" chance of oil selling for less than $100 and "impossible" for oil to sell at or below $50. Only those above the age of 50 were willing to say "most likely" to oil being sold below $100 and "likely to even chance" to oil hitting $50.

Yet here we sit, after four years of a narrow band of oil prices from $105-$120 a barrel, with prices now close to $50 a barrel.

This is hardly the first time the oil industry has seen such a rapid drop in the price of its benchmark product. In recent history look at 2008 for the biggest gyrations, but also look at the drops of 1999 and 1983.

Thus in my career I have seen, so far, four major price "shocks." They are to be expected – although we seem to be caught off-guard each time they occur.

There were others before these – but if we ask, as the industry always asks, "Why?" we are often given the short term, or tactical answer; that is, what is driving this particular price fall.

I would like to take a step back and look at a larger picture to draw some conclusions that should provide, if not a roadmap, then at least a type of guide for the future.

For a quick reminder, when oil was $12 a barrel in 1999 we, as the industry, just wanted oil to rise back to $20 a barrel (or about $45 in 2014 dollars).

The global oil market is both a perfect long-term supply and demand market with no one player or cartel able to control commodity prices, and yet a short-term inefficient market often controlled by emotion and herd mentality.

At best, there usually appears to be a global best efforts finding and development cost for new oil that moves with technology and service prices that during some periods OPEC can influence oil prices to just below that current level in order to slow, but not eliminate, research into new technology that can lower the overall F&D costs.

Eventually however, there will be a new breakthrough in technology that will lower F&D costs per barrel – and thus, there will be an increase in oil production. OPEC can then either lower production to maintain price or keep production to keep market share but allow price to fall.

That is where we find ourselves now.

* * *

In a perfect world these price swings would play out over the months and years that it actually takes for the full impact of the technology to be felt. However, today most oil production is bought and sold through commodity markets and financed on the margin. This has led to investors working harder and harder to get further and further ahead of the production curves – and often getting caught out when the swings start back the other way.

These future calls, derivatives and hedges cause the price gyrations to be larger and much more extreme than warranted.

In 2008 oil traders heeded warnings of "Peak Oil" and drove oil prices up to record prices of over $140 a barrel, which helped precipitate the global economic collapse – and then panic selling six months later drove the price to just below $35 a barrel.

The world supply and demand system did not move that much out of kilter – in fact, there was less than 5 percent change in the supply/demand curve. Within months oil price was back in the $70 barrel range, where it was before the gyrations began.

Based on that experience, I expect that oil prices will rebound to the $80-90 barrel range within six months and be somewhat higher later in the year.

* * *

Herein lays my point: Over my 35-year career I have witnessed three incredibly disruptive innovations in the oil and gas industry that have required major adaptations for the industry to survive.

- The first was the Digital Revolution.

See **Data**, page 52

PROFESSIONAL newsBRIEFS

Nadeem Ahmad, to general manager-exploration North and international assets, PPL, Karachi, Pakistan. Previously senior manager-new ventures, portfolio assurance and international assets, Pakistan Petroleum, Islamabad, Pakistan.

Andrei Belopolsky, to Brazil exploration manager, Premier Oil, London, England. Previously new ventures exploration manager, Premier Oil, London, England.

Gary G. Bible has been appointed to Tennessee Board of Water Quality, Oil and Gas, Nashville, Tenn. He is president, Cougar Dome, in Hellenwood, Tenn.

Mark S. Chalmers, to vice president of exploration-central district, Canadian Natural Resources, Calgary, Canada. Previously exploration manager-north plains, Canadian Natural Resources, Calgary, Canada.

Jennifer Melster, to vice president-geology, Dunn Exploration, Houston. Previously senior staff geologist, Fieldwood Energy, Houston.

Terri Olson, to technical lead-unconventionals, Lithicon Group of FEI, Denver. Previously petrophysical adviser, EOG Resources, Denver.

Mark T. Sunwall, to vice president-geoscience, Baytex Energy USA, Houston. Previously geoscience manager, Baytax Energy USA, Houston.

Max Torres, to exploration vice president, Ecopetrol, Bogota, Colombia. Previously exploration director-Europe and Middle East, Repsol, Madrid, Spain.

Matt Williams, to director of exploration-western United States, Southwestern Energy, Houston. Previously geoscience manager-Appalachia, Southwestern Energy, Houston.

(Editor's note: "Professional News Briefs" includes items about members' career moves and the honors they receive. To be included, please send information in the above format to Professional News Briefs, c/o AAPG EXPLORER, P.O. Box 979, Tulsa, Okla. 74101; or fax, 918-560-2636; or e-mail, smoore@aapg.org; or submit directly from the AAPG website, www.aapg.org/explorer/pnb_forms.cfm.)

IN MEMORY

Louis John Bevacqua, 91
Midland, Texas, May 23, 2014
Eugene R. Brumbaugh, 90
Pensacola, Fla., Jan. 23, 2015
Hubert Yates Crouse, 89
Escondido, Calif., March 2014
Ellis Charles Fernalld, 87
Houston, April 10, 2014
John Sargent Fischer, 86
Houston, Dec. 23, 2014
A.T. Green Jr., 82
Metairie, La., Jan. 10, 2015
Greg Nelson Hummel, 58
Diamond Bar, Calif., Dec. 31, 2014
Adriaan Jan Kapel, 82
Gordon, Australia, Oct. 30, 2014
Karl Forsythe Kennedy Jr., 99
Houston, Aug. 28, 2013
Joe Ben Lewis, 91
Bellaire, Texas, Oct. 15, 2014
Olugbenga Ogunyomi, 64
Lagos, Nigeria, April 2, 2014
Adran Abner Phillips, 90
Evergreen, Colo., Jan. 3, 2015
Boyd C. Pruet, 91
Norborne, Mo., Dec. 30, 2014
John Thomas Schulz Jr., 82
Portland, Texas, April 28, 2014
Ronald E. Young, 75
Midland, Texas, Dec. 22, 2014

(Editor's note: "In Memory" listings are based on information received from the AAPG membership department.)

Letters to the editor should include your name and address and should be mailed to Readers' Forum, c/o AAPG EXPLORER, P.O. Box 979, Tulsa, Okla. 74101, or fax (918) 560-2636; or e-mail to forum@aapg.org. Letters may be edited or held due to space restrictions.

READERS' FORUM

Response to the Crash

Regarding the industry's current down-cycle and $50 a barrel oil:

There is a powerful temptation for corporate leadership to quickly cut back on staff, so as to signal managements powerful new interest in cutting costs. That's nonsense; those are the same staff you depend on to produce profits and guide you to intelligent, really effective cost savings.

Quick-reacting across-the-board job cuts are a CYA for management.

And the right thing to do – quickly?

Stop doing capital-eating projects made stupid by recent events.

Marlan Downey
Dallas

(Editor's note: Marlan Downey, an AAPG Sidney Powers medalist and past AAPG president, has been the chief executive of one company or another continuously since 1979.)

Data

from page 50

Remember, 35 years ago all logs were printed on paper at the wellsite, plus on film. There was no 3-D seismic and no computers. Communication was done by office visits, landline telephones, facsimile or telex.

But now, the ability to store, manipulate, visualize and work with digital data in 3-D space has allowed a generation of earth scientists to understand and to discover more oil and gas in the last 30 years than in the preceding 100 years – yet at a time when it is much more difficult to find oil and gas deposits now, because most of the easy big fields have been located.

This has led to oversupply issues and the price collapses in the 1980s and '90s.

▸ The second disruptive innovation was the ability to explore and produce in the deep marine environment.

Thirty-five years ago 300 feet of water (100 meters) was considered close to the limit of technology. Today Shell is developing the Stones field in 9,500 feet of water (2,900 meters) in the Gulf of Mexico, and there are deepwater exploration and/or development wells around every continent except Antarctica.

Currently over six MMboe/d are being produced from deepwater wells, primarily from the Gulf of Mexico, Latin America (Brazil) and Africa.

Yet deepwater basins are still considered frontier areas with a very low drilling density and there are many untested basins. The deepwater oil production ramped up from about 1.5 MMboe/d in 2005 to just over four MMboe/d in 2008, just as the world economies crumbled in the largest economic crisis in over 50 years.

Thus this oil success story became partly a victim of its own success.

▸ The third disruptive innovation is the Unconventional Revolution, or using the combination of several technologies (horizontal drilling, hydraulic stimulation, pad drilling) to economically produce gas and some liquid hydrocarbons from very low permeable formations previously thought to be far too "tight" to ever be commercial.

Generally known in the press as shale gas or "fracking," these unconventional reservoirs trap the hydrocarbons by capillary forces – not by traditional buoyancy forces – and demand a different style of evaluation and development.

Although horizontal drilling, stimulation and pad drilling all have been used for over 50 years, it was the application of all three applied to the low permeability reservoirs that created a disruptive innovation – and has altered U.S. energy markets.

Starting with the shale gas drilling in 2008, the industry has oversupplied the U.S. gas market and dropped the price of gas from $7/btu to a current $3.40/btu, and has saved the U.S. economy approximately $200 billion since 2008.

U.S. liquids production which hit an all-time high of 10 MMBbl/d in 1971, declined to a low of 5.3MMBb/d in 2008 before unconventional drilling has brought it back to over 9MMBbl/d in 2014 (EIA).

Thus, this disruptive innovation added almost 4MMBbl/d of liquid production to the world market in 2014 as the European, Chinese and Indian economies announce major slowdowns.

The short-term market reaction should not have been totally unexpected – but expecting the price to likewise stay below $70 a barrel does not appear to have any basis.

It remains to be seen how resilient unconventional operators will be, but current analysis indicates that this rapid price swing can be disruptive to some of the overleveraged and some of less efficient operators.

Most of the better operators will weather the price storm in good fashion and continue their innovation learning curve.

The real test will be to take these innovations and apply them to formations outside of North America. There are multiple tests under way in Latin America, Europe, Australia and China, but to date none have reached truly commercial scale.

* * *

Oil and gas currently are essential commodities for modern life, but subject to market demands and the eternal fluctuations in supply and demand.

It is important to try to keep a larger view on the big changes, those disruptive innovations, which demand a change in the way we do our business.

Each one of the disruptive innovations of the past 30 years began with existing technology and built on it; each one started on the fringe and grew until it became dominant.

None started from scratch as a "change the world" idea, but in time each did just that.

There will be new and different innovations, and it is difficult to predict where they will come from. There are several new applications of technology with the potential to radically change our business, from wastewater to nano-technology.

Anyone who predicts the future by not anticipating radical changes will repeat the mistakes of the past. We are an innovative industry – so go disrupt things!

Keep it turning to the right.

(Editor's note: Jeff Aldrich, an AAPG member who received the AAPG Distinguished Service Award in 2002 and has worked with companies around the world, is with MHA Petroleum Consultants in Denver.)

CLASSIFIEDADS

POSITION AVAILABLE

Director, Advanced Energy Technology Initiative

Illinois State Geological Survey
Prairie Research Institute
University of Illinois at Urbana-Champaign

The Illinois State Geological Survey (ISGS) is part of the Prairie Research Institute (PRI) at the University of Illinois at Urbana-Champaign which is centrally located between Chicago, St. Louis, and Indianapolis. PRI houses five large scientific surveys covering a wide range of expertise including biology, water resources, climate, geology, sustainable technology and archaeology. The ISGS is a premier state geological survey, with over 200 scientists and technical support staff, serving the needs of the public, government, and industry with earth science information and research relevant to natural resources, environmental quality, economic vitality, and public safety. The University is a land-grant institution that provides access to world-class laboratory and academic facilities, Big Ten athletic events, and internationally acclaimed cultural opportunities.

We are seeking an individual to provide leadership, clear scientific vision, and direction to the subdisciplines and staff members that comprise the Advanced Energy Technology Initiative (AETI) at the ISGS. The leadership skills of the individual will encourage multidisciplinary, project-based research within AETI and throughout ISGS, other Surveys, and University related to energy issues; develop, implement, and administer research and service programs of the AETI; and facilitate coordination, communication, and teamwork throughout the PRI and the University. As the Director of AETI, the individual will promote AETI services and capabilities to a variety of stakeholders including government funding agencies, corporations, and legislative representatives. The individual will continue to maintain AETI's domestic and international reputation as a global leader in addressing energy issues.

Ph.D. in geological science, engineering, or related discipline with career emphasis related to energy resources and 15 years of combined research and managerial experience beyond the completion of master's degree. Demonstrated vision, capability, and experience to address challenges facing society related to the advanced energy fields, such as carbon capture and storage, mitigation of fossil fuel emissions, water for energy resource development and power generation, public engagement and education on energy issues, unconventional oil and natural gas resource assessment, natural gas geologic storage, and enhanced oil recovery.

Applications must be received by May 15, 2015. Applicants may be interviewed before the closing date; however, no hiring decision will be made until after that date. To apply, please visit https://jobs.illinois.edu/academic-job-board to complete an online profile and to upload a 1) cover letter, 2) résumé/CV, 3) the names and contact information (including e-mail addresses) of three professional references. All requested information/documentation must be submitted for your application to be considered. An incomplete application will not be reviewed.

For further information please contact Lori Walston-Vonderharr, Human Resources, Illinois State Geological Survey, at lwalston@illinois.edu or 217-244-2401.

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DIRECTOR'S CORNER

Hanging On Helps Today; Preparation Helps Your Future

By DAVID CURTISS

Has it happened to you?

It's happened to me: Friends in the industry emailing me to say that they have just been laid off.

Or worse, you're the one sending the email. It has happened to you, and you are joining a growing number of AAPG members that I meet who have been caught in the wave of downsizing that is washing over our industry.


CURTISS

As exploration and production companies and service companies react to the slump in oil prices by significantly curtailing operations and cutting staff, I have to ask myself whether we've learned anything as an industry from previous downturns or whether we are destined to repeat our past mistakes.

Yes, our commodity business is cyclical. There are good times and there are bad times.

But it is science, talent, risk-taking and experience that generate the good times. It's geoscientists and engineers that form the core of that activity, and they currently feel like those silent movie stars who were always trapped in absurdly treacherous situations, dangling precariously, tightening their grip, hoping not to slip, and waiting.

Now what?

Well, the first thing each of us can do is accept responsibility for the situation we find ourselves in. That doesn't mean we created the situation – though that can be a factor, and if it is we need to recognize it – but rather that we accept responsibility for how we respond to it.

Audiences loved the way American actor, comedian, director and stunt performer Harold Lloyd, a star of the silent film era, always found himself in absurdly treacherous situations – and yet always managed to find a way to better days. His secret? Preparing in the good times for ways to be resourceful in the bad times that he knew would follow.

We've chosen to work in a volatile business. We need to own that.

And we need to prepare accordingly.

* * *

Mental preparation is essential – thinking through how you'd respond to a sudden negative shift in your situation, and it's the preparation that is most frequently ignored and left undone.

Why? Because figuring out how to make the mortgage payment if your family income drops is not fun. Yet, accepting responsibility means doing that hard work.

And speaking of preparation, where is your résumé right now?

Where is the contact information for your personal and professional network that you've developed over the years?

Our employers hand us smartphones and laptops that become extensions of ourselves. We spend hours with these devices, often blurring the boundary between personal and professional. It's a persistent trend, particularly with our younger colleagues, and there's nothing inherently wrong with it.

But I promise you that your employer's policy manual contains no blurry lines or fuzzy definitions. If it's on a device that belongs to them, it's theirs.

So, I ask again: Where is your résumé?

Where are your personal and professional contacts? Are they under your control?

This type of preparation is about protecting your downside, ensuring that if something bad happens that you have given yourself the best chance to respond in a productive way. It's not fun, but it's necessary.

Applaud yourself for doing the work!

* * *

Equally important is building your skills and network. There is no better time than right now to ensure that you are technically proficient, honing your skills and looking for deliberate ways to add value to your employer or to create a new path for your career.

Charlie "Tremendous" Jones was a 20th century American motivational speaker and author who was famous for saying that "you will be the same person in five years as you are today except for the people you meet and the books you read."

As I mentioned last month, the AAPG World-Class Education Conference scheduled this month in Houston is a great way to gain new skills and expand your network. And I've written repeatedly about how being involved in AAPG, both as a participant and as a volunteer, can benefit your career.

Perhaps now is the time for you to take this step.

It's no coincidence that most of the conversations I have with AAPG members who have been laid off are at events where they are building new skills and meeting and talking to people.

They also have a gleam in their eye, because while downturns are unpleasant and can be painful, they are full of opportunity.

Who will you be in five years?

Hold on, friend. Hold on.

DIVISIONS REPORT: DEG

DEG Invites Open Dialogue

By JEFFREY G. PAINE, DEG President

AAPG members, like all other segments of humanity, hold a wide range of opinions and beliefs about controversial topics, including those on environmental issues that affect the energy industry.

Individual perspectives vary for many valid reasons, including experience, knowledge base and personal value systems.

Environmental issues related to the industry have been perennial favorites for divergent views, and today these views are as divergent as ever! It makes for exciting times and lively discussions at conferences, workshops and meetings – and even in personal conversations.

Today's topics may differ from yesterday's, but the convictions and passion are similarly felt from one generation to the next.

In the present, nary a day goes by that we don't hear a news piece, see a headline, read a story or hear an opinion on these and other issues: climate change, carbon sequestration, induced seismicity and hydraulic fracturing!

* * *

When you get a chance, go to DEG's website and take a look at our Goals and Objectives statement. There are seven bulleted points there. They begin with active words like Educate, Communicate, Support, Apply, Promote, Establish and Provide – and many of them specifically mention AAPG members and the general public as the audience.


PAINE

Most relevant to this discussion, DEG serves to:

- Educate us about issues that affect the energy industry.
- Communicate AAPG's commitment to simultaneously protect the environment while responsibly developing natural resources.
- Support and encourage research on the effects of exploration and production on the environment – and then make those results available to the public.

* * *

Happily, DEG has two principal venues to reach members and the public through the written word.

- One is a peer-reviewed, scientific venue – the **Environmental Geosciences** journal, which now has been with us for more than two decades and has been growing in stature and content under the direction of Michele Cooney, our new editor-in-chief, and her predecessor, Kristin Carter.

This is the venue for researchers to deliver scientific results on environmental issues relevant to the energy industry. The process is simple but sometimes arduous, and anyone can submit a manuscript on any topic.

The editor selects several qualified reviewers to evaluate the manuscript and recommend acceptance, revision, or rejection as necessary. Ultimately the editor decides whether the manuscript is worthy of publication based on the opinions of the reviewers and the strength of the article.

It is important to recognize that just because an article is published in Environmental Geosciences, it does not imply DEG or AAPG as an organization endorses the results, interpretations or conclusions.

If an article makes it through the review process and is published, it becomes fair game for science-based rebuttals in the same or other venues.

- DEG also has a less-formal written communication outlet: **Spheres of Influence**, a newsletter-style publication that is issued quarterly under the direction of managing editor Kristin Carter.

In addition to publishing news of interest to DEG members, Spheres of Influence solicits and receives voluntary submissions from DEG members on various topics. These submissions undergo much less stringent review and are published at the discretion of the editor.

Each piece represents the viewpoint of the author solely, not the editor nor DEG nor AAPG.

These articles commonly serve as discussion starters and are intended to maintain lively debate and discourse within the DEG community.

* * *

We who are responsible for maintaining DEG as an active assembly of AAPG members greatly appreciate the efforts of those who have taken the time and effort to write and submit opinion and editorial pieces, and we encourage others whose opinions and perspectives may differ to join the discussion.

It's part of what makes DEG an organization that can make an impact.

Keep the material coming!

this much

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