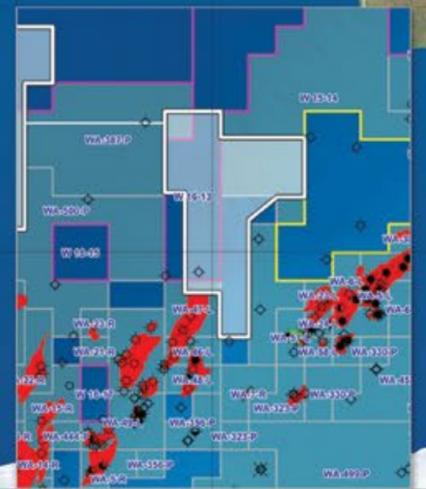
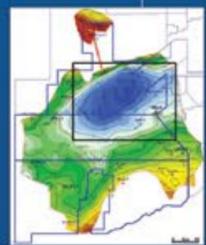


The Age of the Super Basin



AAPG
EXPLORER

JANUARY 2018

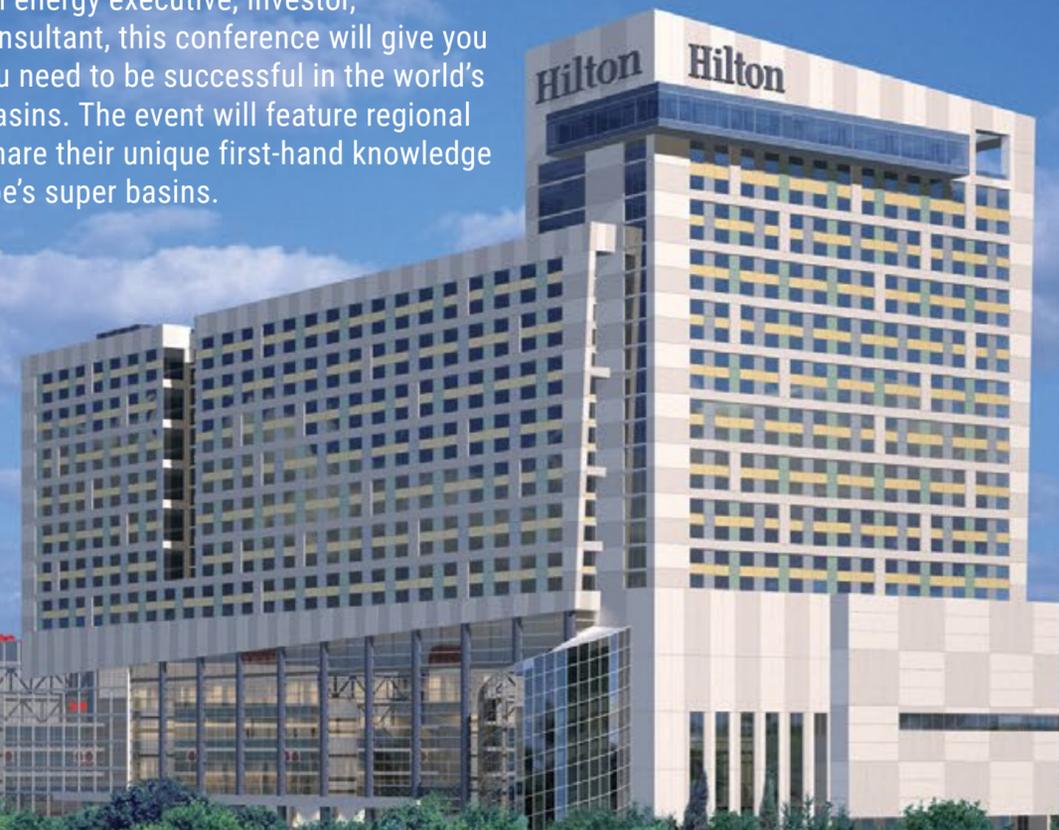


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- How do "above ground" issues like politics, access, mineral ownership, and geography influence realizing the full resource potential of each super basin?
- Will a basin be a regional or global disrupter?
- What are the critical geoscience elements that contribute to success?

Basins From All Over the World!

- **Super Basins**, Bob Fryklund, Pete Stark, IHS Markit
- **Permian Basin**, Scott Sheffield, Pioneer
- **Overview of Greater Super Basin concept how it might evolve**, Scott Tinker, Tinker Energy Associates, LLC
- **Appalachian Basin**, William A. Zagorski, Range Resources
- **Anadarko Basin**, Rick Fritz, Council Oak
- **Going Beyond the North American Mudrock Super Basin Plays: The Unconventional Development of Conventional Reservoirs**, Richard K. Stoneburner, Pine Brook Partners
- **Williston Basin**, Mark Williams, Whiting Petroleum Corporation
- **The Western Canadian Super Basin, a Confluence of Science, Technology, and Ideas**, Paul MacKay, Shale Petroleum Ltd.
- **California, San Joaquin**, Kurt Neher, Berry Petroleum Company, LLC
- **Alaska- North Slope**, David Houseknecht, USGS
- **Gulf of Mexico Offshore Evolution of Past, Present, and Future Plays**, Cindy Yeilding, BP America
- **Global Overview**, Robert Ryan, Chevron
- **Americas Unconventional Energy Opportunity – an update**, David Gee, The Boston Consulting Group
- **Mexico, Tampico Mizantla Basin and Sur Este Basin**, Ivan Sandrea, Sierra Oil and Gas
- **Neuquén Basin**, Carlos Macellari, Tecpetrol
- **North Sea**, John Underhill, Heriot-Watt University
- **The Arabian Basins: Prolific Producers with bright future still**, Ibraheem Assa'adan, Saudi Aramco
- **North Africa – a rejuvenated Super Basin**, Jonathan Craig, Andrea Cozzi, ENI
- **Brazil Pre Salt, Santos Basin**, Mario Carminatti, Petrobras
- **Western Siberia**, Alexei V. Milkov, Colorado School of Mines, Vladimir Vyssotsky, BP Russia, Andrei S. Bochkov, GazpromNeft
- **COP Operator Stimulated Rock Volume**, Greg Leveille, ConocoPhillips
- **Venture Capital Leading Edge Technology**, Trond Unneland, Chevron
- **Big Picture Geophysics and Reservoir Packages**, Brian Horn, ION

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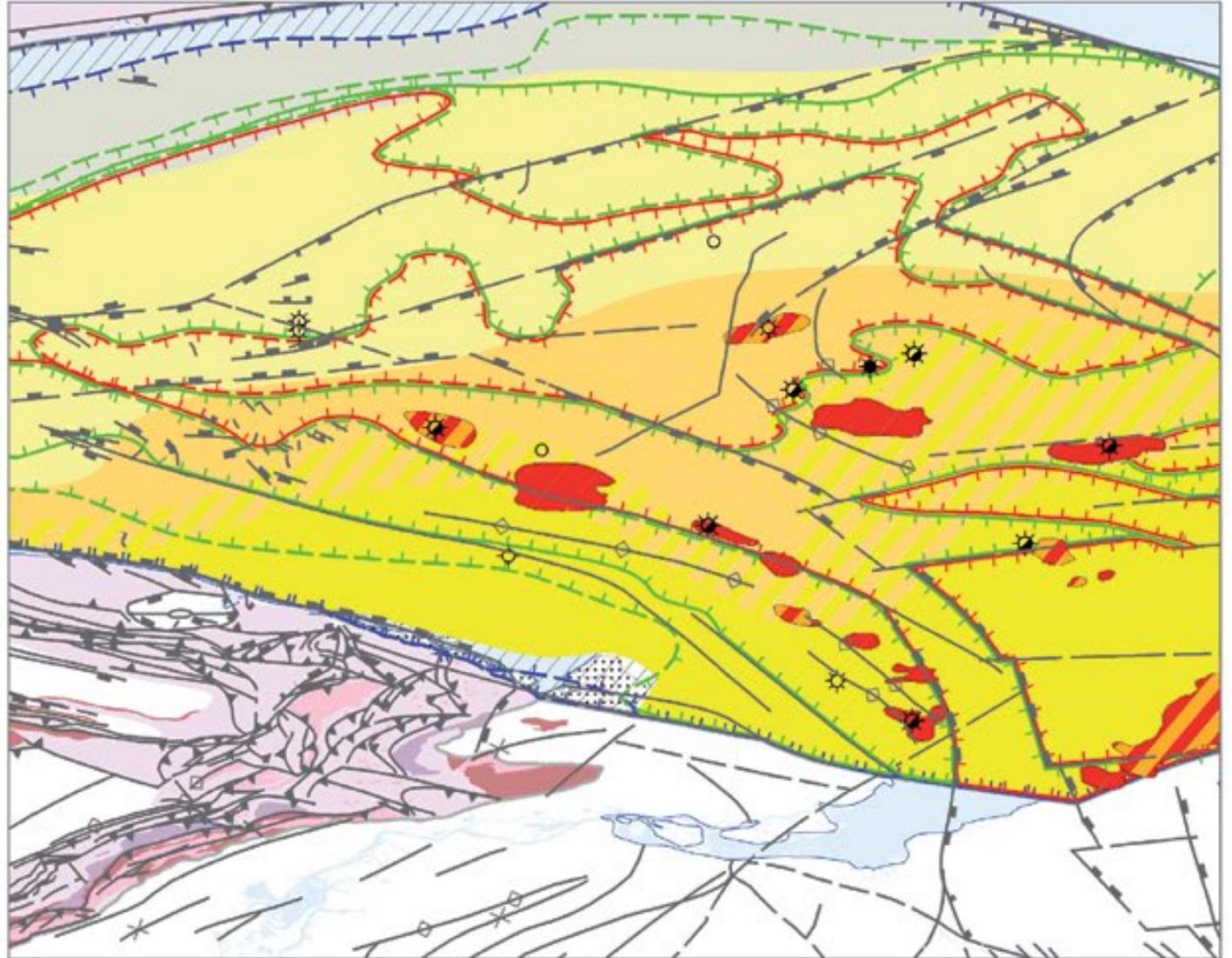
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President's Column

Never Stop Exploring!

Explore all the new AAPG content and events in the New Year



An amazing video and archival celebration of AAPG's first 100 years is now available online, and it's a page that every member will want to visit again and again. AAPG's 100th Anniversary website, including the historic video interviews comprising the GeoLegends sessions, can be found either through a link on the AAPG homepage (under "Resources"), or by going directly to 100Years.aapg.org.

There you'll find the results of work that has been in progress for more than a decade, involving a large number of dedicated AAPG

Members who helped provide content for a website that celebrates the past even as it inspires future generations of petroleum geoscientists.

A personal note: I served as the founding chair of the committee that helped define the project's vision under the 100th Anniversary Committee, but the work you'll find was largely possible through the efforts of past AAPG President Paul Weimer and 2017 Michel T. Halbouty Outstanding Leadership Award recipient Ed Dolly.

The 100th Anniversary website includes

“Those who work to make AAPG a better society enrich both the society and themselves . . . What are you going to do for AAPG in the New Year?”

video presentations from the wildly successful Discovery Thinking Forums that have been offered at our ACE annual conventions and ICE international conferences. I've been personally involved in this part of the project and I know firsthand that the speakers who are featured are among the industry's most amazing explorers.

The century's "Top 100 Papers" is a list that includes the geoscience's seminal papers, overseen by past AAPG President Randi Martinsen. The "Top 100 Field Trips," were compiled by past AAPG President Steve Sonnenberg, and former AAPG executive director Rick Fritz.

And, perhaps the site's most impressive feature are the GeoLegends interviews, a series of 50 videos with 62 key geoscientists who made game-changing discoveries and significant scientific contributions to the profession and industry, all of whom describe their thinking and the efforts that brought success. Produced by Weimer and Dolly, those interviewed include 16 Sidney Power Memorial awardees, four Michel T. Halbouty Outstanding Leadership Award recipients and eight winners of the Norman H. Foster Outstanding Explorer Award. The entire site is filled with information that is intriguing, inspiring and, best of all, an important resource to help enhance your value as a geoscientist.

But be careful – If you binge watch these inspirational talks, you just may go out and find a giant field of your own, develop a new play, create an innovative technological breakthrough or produce more energy to make the world a better place!

Also, as you'll see explained elsewhere in

this issue, there is an exciting new Explorer website that launched this month, which can be found at Explorer.AAPG.org.

Explore Our Annual Meeting

My hat is off to Michael Vandenberg, 2018 Annual Convention and Exhibition (ACE) general chair, and his team for organizing the event around the theme "ACE 101: Bridging Fundamentals and Innovation."

The meeting will be May 20-23, 2018 in Salt Lake City Utah. There will be seven special sessions (see next month's Explorer for details). Other highlights include 13 field trips, an incredible core display (massive in scale), and Pre-Salt sessions. Now is a great time to make plans to attend!

Explore the World's Most Petroliferous Super Basins!

AAPG Global Super Basins Conference in March 2018 will be a new quick-to-market conference. I have been writing about this for a few months, and it is the editorial focus of this issue of the Explorer that you now hold in your hands (or on your device). It is an initiative to help provide all AAPG members the opportunity to share best practices in the most petroliferous provinces around the globe. The speaker list is a "Who's Who" of basin experts and big thinkers with 29 global speakers including at least three AAPG "Outstanding Explorers."

At the conference, we plan to engage

See Content, page 6 ►

Super Basin

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ON THE COVER:

The Permian Basin, the Gulf of Mexico, the North Sea, Williston, Neuquen, Oman and Niger Delta are among 25 identified "super basins" in the world. Left: Gravity map of the Sureste Basin in the GOM.

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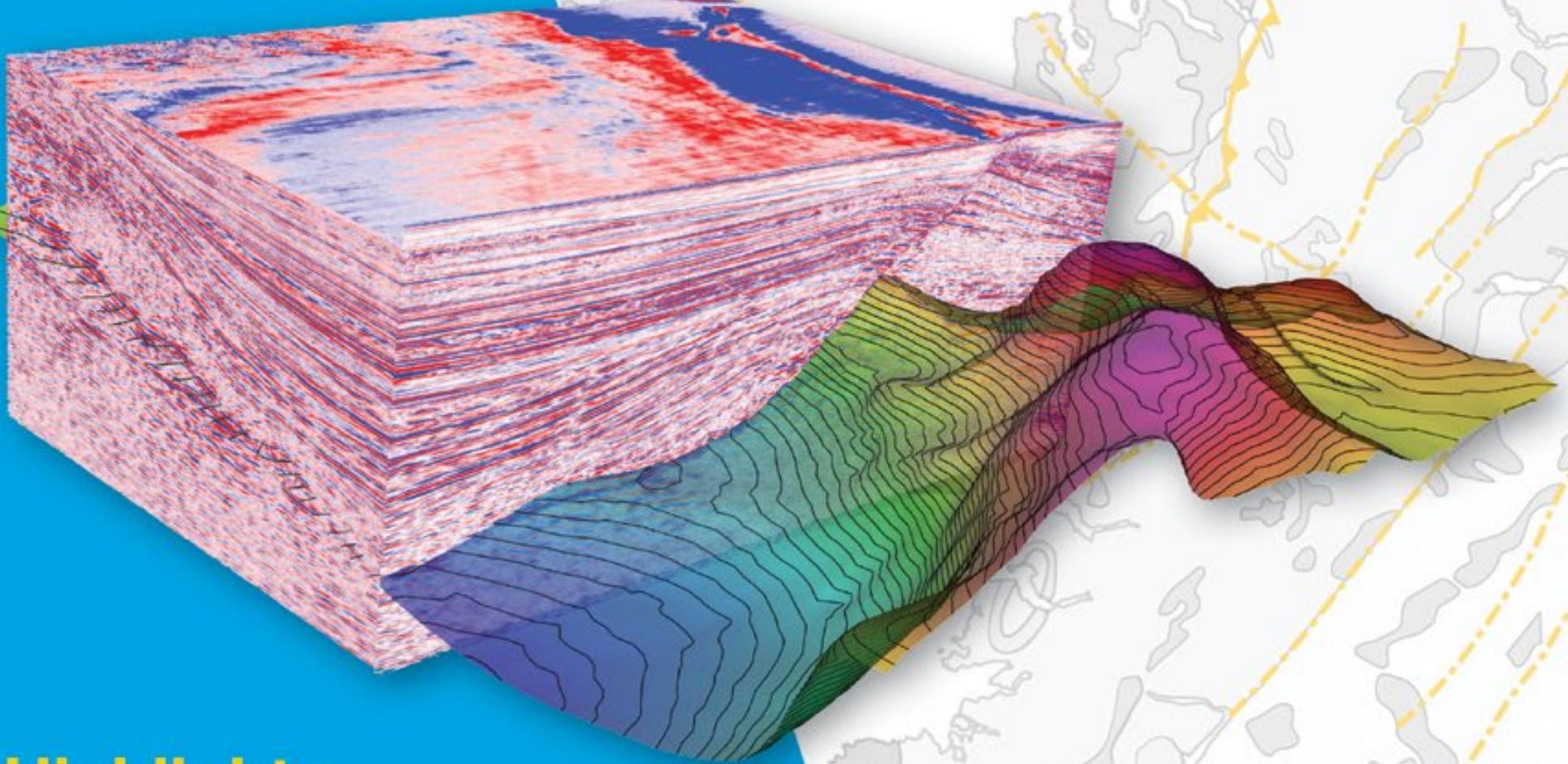
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The YP Mini Summit at the University of Houston last November

Content from page 4

global energy leaders, energy advisers and members of the investment community. A launch party is available at CERA week Sunday March 4, 2018 to the first 125 people who register for the Mar 27-29 AAPG conference on the AAPG website. Details can be found in companion articles this issue. Plus, we are planning many super basin articles and enhanced content in the AAPG Bulletin, so there's more to explore!

Exploring Ways to Strengthen AAPG's Content Engines

In November last year, AAPG leaders met for a working weekend at the University of

Houston campus. In addition to handling important aspects of AAPG's mid-year business, we shared best practices through committee cross talk.

I selected the University of Houston because it is an energetic and forward-looking venue connecting AAPG to a larger multidisciplinary energy community with excellent public outreach opportunities. The AAPG program included more than 50 students. My favorite moments:

- ▶ Recognizing future industry workforce by personally presenting a copy of the "Heritage of the Petroleum Geologist" book in appreciation for poster presentations at the Science Break to 30+ students.

- ▶ Thanking each of AAPG's committee chairs or representatives for sharing news and goals about their committees, highlights and new ideas on how we can work together.

- ▶ Alan Wegener of AAPG staff gave a great summary of "What's going right at AAPG!" This was informative, uplifting, and well timed. AAPG staff have been doing a great job in light of a 40-percent reduction in work force over the last several years. A positive tone is appropriate in light of all that has been accomplished by the remarkable men and women of AAPG staff.

- ▶ Other highlights included Allyson Anderson Book (executive director of AGI), Steve Sonnenberg, (AAPG past president), and Denise Cox (AAPG president-elect) speaking on future work force trends.

- ▶ We featured industry leaders like Paul Mann, Bob Fryklund and Chandler Wilhelm. David Curtiss chaired a Corporate Advisory panel discussion on energy trends for the future, which also included perspectives by Bobby Ryan and Bill Maloney.

- ▶ Innovative Revenue growth panel facilitated by Henry Pettingill and Niven Shumacher.

- ▶ YP Mini Summit, chaired by Meredith Faber and Jonathan Allen.

- ▶ House of Delegates Midyear Meeting, chaired by HOD Chairman David Entzminger and Justin Vandenbrink HOD Secretary Editor.

- ▶ Conversations with Section and Region Leadership, facilitated by Vice President of Sections Dan Schwartz and Vice President of Regions David Cook.

- ▶ Forward planning by AAPG's divisions, including a business meeting by the Division of Professional Affairs chaired by DPA President Jim Hill.

- ▶ My remarks focused on how AAPG members help provide abundant and affordable energy that positively impacts our environment and economy. Super basins drive sustainability and security – an important part of AAPG's future.

Explore Your Options to Contribute to AAPG

There are many ways for all AAPG members to contribute. You can present a paper or poster, serve on a committee, chair a conference session, submit an article to the Bulletin, write a book or publication, teach a short course, organize a field trip, speak to students, stand for office and nominate a colleague for an award.

Thanks to AAPG leaders who have contributed in these and other ways.

I have personally done all of these and found each experience richly rewarding. You can also contribute to Technical Interest Groups (TIG) or Special Interest Group (SIG) postings online: <http://aapg.to/TigsSigsOnline>.

Those who work to make AAPG a better society enrich both the society and themselves. So, I end with a question: What are you going to do for AAPG in the New Year?

Charles A. Sternbach

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The Imminent Age of the Super Basin

With new discoveries few and far between, energy salvation lies in mature fields



STARK

“We looked at the Permian Basin, left for dead a decade ago. And — Eureka! Let’s look at super basins as being a whole new paradigm.”

Can super basins save the planet? IHS Markit, the international industry analysis firm, estimates the world will need to replace production of more than 14.5 billion barrels of oil equivalent annually by the year 2040.

The shortfall will come from natural declines in currently producing fields.

“We need to replace about 40 million barrels of new oil production a day. How are we going to get there?” said Pete Stark, executive director of upstream research for IHS Markit in Englewood, Colo.

Where will all the hydrocarbons come from?

A traditional answer would be, “From new oil fields discovered through exploration.”

And that’s an excellent answer.

But probably wrong.

Worldwide exploration results have slumped badly in recent years. A period is imminent during which we’ll see very few newly discovered major oil fields coming online.

So major oil discoveries won’t prop up worldwide production totals in the 2020s, and won’t lead to additional exploration opportunities in the 2030s. There just haven’t been many big, new oil fields found lately.

“The frontier exploration picture for the past half-dozen years has been getting worse and worse,” Stark said. “It looks like last year may have seen the lowest level of conventional discoveries since 1952.”

If conventional exploration efforts aren’t helping much, you might think the new oil will come from a worldwide increase in unconventional resources production. That’s another insightful guess. And, again, probably wrong.

“Poland had a big (unconventional shale) effort going on several years ago. And everybody backed away. There’s been an effort going on in South Africa,” but it was slowed by popular opposition to hydraulic fracturing, Stark noted.

For whatever reasons, unconventional play development has not spread outside the United States and Canada the way many expected. The one significant exception has been the Neuquen basin in Argentina, where the Vaca Muerta shale is a target for both unconventional oil and natural gas.

The Permian Prototype

How can the world replace 40 million barrels of oil production a day?

Stark said he and an IHS Markit colleague, Bob Fryklund, were pondering that question when their attention focused on burgeoning activity in the Permian Basin.

“When we looked at the future opportunities in the world, we looked at the future of unconventional development. We looked at enhanced recovery,” Stark recalled.

“Then we looked at the Permian Basin, left for dead a decade ago. And — Eureka! Let’s look at super basins as being a whole new paradigm,” he said.

Stark and Fryklund applied a Permian Basin yardstick to mature basins around the world, looking for areas that had produced at least 5 billion boe to date with at least another 5 billion boe production potential remaining.

Then they tightened up their criteria, requiring a mature basin to have several characteristics to earn the “super basin” designation:

- ▶ Productive capacity and additional production potential.
- ▶ Two or more source rocks and/or petroleum systems with stacked pay.
- ▶ Adequate oil and gas infrastructure in place.
- ▶ Favorable — or at least nonrestrictive — laws and regulations in place.
- ▶ A developed and accessible service and supply sector.
- ▶ Ready access to markets.

In the end, they identified 25 basins around the world that qualified as super basins. And startlingly, they calculated remaining recoverable oil from mature basins at 859 billion barrels.

“What we realized is that horizontal drilling technologies can be applied to any producing basin. It doesn’t have to be 5 billion (additional boe production potential),” Stark said. “The horizontal technologies are exportable around

the world, and you don’t have to have extensive fracturing infrastructure in place.”

The industry’s typical recovery factor is around 34 percent of hydrocarbons in place, he noted. Move that to 44 percent and “you get 600 billion barrels of additional supply,” Stark noted.

“We’ve had a remarkable improvement in productivity from horizontal wells. How much further can we go? Are we in the second inning of a nine-inning ball game, or are we in the eighth inning?” he said.

Critical Issues

Already in the United States, Stark said unconventional development techniques have improved recovery by 10 percent, and “if we move that up to 20 percent — well, gosh, can we produce another 10 million or more barrels a day?”

“We’ve identified more than 400 different oil-producing reservoirs in the U.S. that have had horizontal wells drilled into them. Many have not had further development because of the dramatic price decline in recent years,” he observed.

Tapping into the additional production potential of super basins by using unconventional development techniques is a recent concept, but there’s a growing belief that it will be critically important to the oil industry in coming decades.

In evidence of that, AAPG and IHS Markit are teaming up to host the Global Super Basins Leadership Conference on March 27-29, 2018, at the Hilton Americas Hotel in Houston.

The conference is the first of three major steps AAPG will take to give its members the tools they need to understand super basins and related emerging realities in the industry, said Charles Sternbach, AAPG president and president of Star Creek Energy Co. in Houston.

Second will be a series of AAPG Bulletin papers on the geology, fields, key formations and key plays in specific basins, “so people can go back to these papers again and again as new concepts evolve,” said Sternbach.

Third, the 2018 AAPG Annual Conference and Exhibition in Salt Lake City will include a special forum

on super basins.

Development in mature basins and known producing formations doesn’t mean exploration geologists are going away, according to Sternbach. The world will still need a base supply of conventionally discovered oil.

“I’m asked all the time, ‘Is there going to be more oil in new places or more oil in old places?’ My answer is, ‘Both,’” he said.

Sternbach thinks super basins will be so important to future production that he makes them the first of three critical-issue “S’s” for the oil industry.

▶ Super Basins

“What we’re realizing is that a lot of the energy is back in the old basins. We’re going back to the basins that keep on giving,” he said.

▶ Sustainability

“Changing out coal for clean-burning natural gas freed by hydraulic fracturing is a major environmental upgrade,” Sternbach noted.

▶ Security

“The geopolitical aspects of these things are very important, and not as often talked about,” he said.

The Best Choice

Whether or not the world’s mature basins can produce another 859 billion barrels remains to be seen. If nothing else, the number is an attention-grabber, Sternbach said.

“Yes, it’s an astounding number,” he observed. “It’s a startling number because it points out what’s accessible if everyone adopts these practices.”

To meet the coming challenge of production replacement, he said, the industry has to focus on four E’s: energy, environment, economy and education.

The educational process will be especially important in explaining the benefits of unconventional development technology, including hydraulic fracturing, he said.

Sternbach noted that several countries in Europe and some others have already rejected unconventional development.

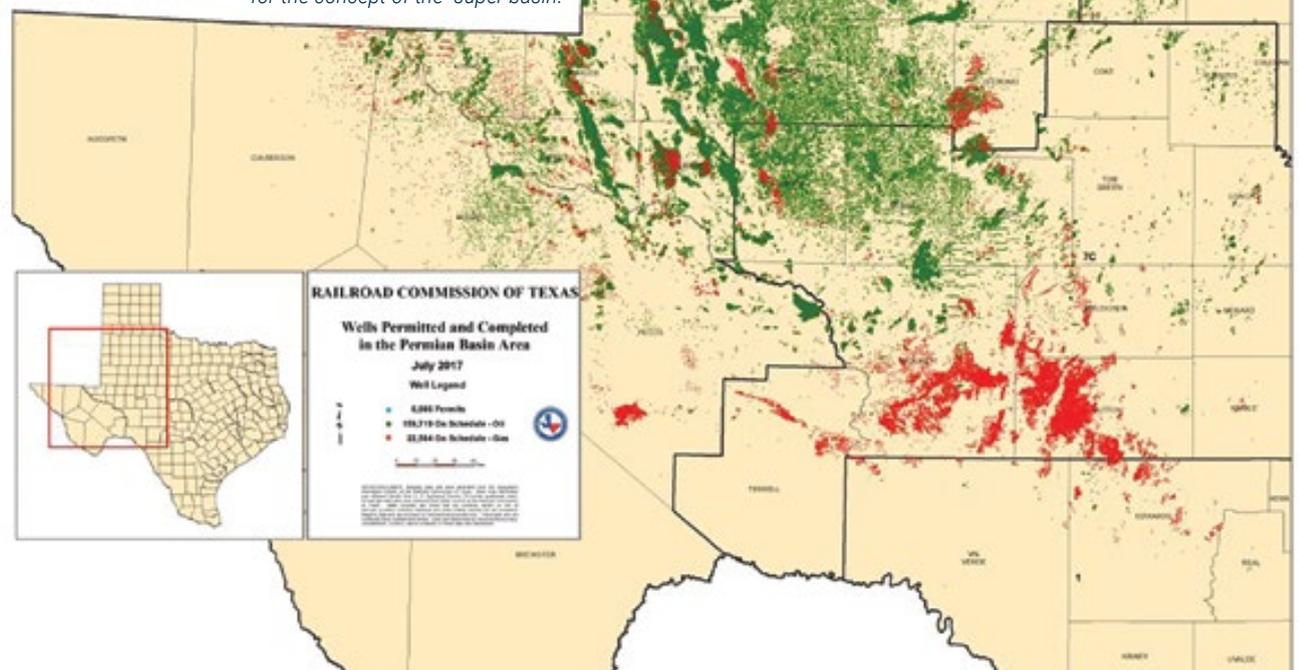
“It’s a cultural choice they choose to make. To me, everybody has to make their own energy choices,” Sternbach said. “We want the whole world to know what the best practices are in these super basins, so people can make the best choice.”

“Yes (859 billion is) an astounding number. It’s a startling number because it points out what’s accessible if everyone adopts these practices.”



STERNBACH

The Permian Basin is the prototype for the concept of the “super basin.”



Bottom-Line Benefits of Diversity

How differences make organizations stronger

Heighted creativity. Enhanced problem-solving and decision-making. Improved risk management.

These are just some of the benefits of diverse workplaces, according to panelists for "Bottom Line Benefits of Diversity," a special session held at the AAPG International Conference and Exhibition (ICE) in London late last year.

The session highlighted how diversity benefits both industry and research organizations, providing skills and creativity leading to sounder economic decisions and enhanced scientific inquiry.

Institutionalizing Diversity

For Liz Schwarze, general manager of exploration for Chevron Africa and Latin America Exploration and Production, diversity makes good business sense.

A first-generation American born to German immigrants, Schwarze moved frequently growing up. Her ability to adapt to different cultural environments served her well when she joined Chevron in 1990.

"From my first day at Chevron I reaped the benefits of diversity in the workplace – diversity of education/technical degree, diversity of experience level and gender diversity," she said. "Two of my first three team leads were women and one of our senior managers in the location was a woman, so I never saw any barrier to being successful and moving up in responsibility as a woman. That was empowering from the beginning."

Schwarze's talk, "Better Together:



Chloé Asmar (left) and Linda Lerchbaumer of OMV Upstream presented "Diversity in Central/Eastern Europe as Seen from both the Inside and the Outside."

"We have to reach a stage where we don't talk about diversity anymore ... That's the goal."

the Role of Diversity in Decision Quality," was about how Chevron's institutional commitment to diversity and inclusion benefits the company and its more than 50,000 employees.

"Our progress on diversity and inclusion is driven from the top," she said. "Our chairman recently stated via LinkedIn that the business case for inclusion is simple:

if the full spectrum of talent we've hired isn't put in a position to realize its full potential, the company won't achieve its full potential."

One third of Chevron employees in the United States are people of color. Women represent 26 percent of the workforce, and 32 percent of leadership positions worldwide are held by women and non-

white males.

Schwarze said this diversity helps Chevron maintain its license to operate and to manage risk.

"Our long-term business success is not just how we build facilities, devise processes or make products, but also is tied to what happens in diverse communities and countries around the world because of our working there and after we leave," she said.

"Risk management for geotechnical and petroleum engineering staff previously

See [Homogeneity](#), page 11 ▶



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A 'Once-In-A-Generation' Opportunity

America's future is still in unconventional

Unconventional resources represent a bright opportunity for the United States' economic and energy future, but that is in no sense guaranteed.

A misinformed public debate about the impacts and merits of hydraulic fracturing in particular and the oil industry in general threatens that future, so it greatly depends on the industry's ability to address ongoing controversies and arrive at mutually-beneficial compromises.

That's according to David S. Gee, senior partner and managing director of Boston Consulting Group.

Back in 2015, Gee, along with Michael E. Porter and Gregory Pope, compiled a 72-page report for Harvard Business School and BCG, entitled "America's Unconventional Energy Opportunity: A win-win play for the economy, the environment, and a lower-carbon, cleaner-energy future." It was an economic, environmental and climatic assessment of unconventional gas and oil development in the United States.

"Unconventional gas and oil resources," he said, "are perhaps the single largest opportunity to improve the trajectory of the U.S. economy, at a time when the prospects for the average American are weaker than we have experienced in generations."

Gee will give an update the report called, appropriately enough, "Americas Unconventional Energy Opportunity: An Update" at the upcoming AAPG Global Super Basins Leadership Conference in Houston.

Gee believes that while much has changed, much has not, and even that which has, may not change the conclusions of the original report. Gee's fear now, as it was then, is that a divisive and often misinformed debate about unconventional – and this comes from both business and environmental groups – is, as he wrote then, "jeopardizing a once-in-a generation opportunity to change America's economic and energy trajectory."

The report, as well as the update, is motivated, he said, by that gridlock which is threatening America's unconventional energy development.

"The (original report) came out when oil prices had collapsed, and there was a line of reasoning that the study we did back then was no longer valid," he explained.

And while Gee and his team are still in the process of updating the report for the conference, he insists that the findings, in fact, are still on the money.

Buckets of Caveats

"There is no inherent trade-off between environmental protection and company profitability," he said.

There are, however, in his words, "buckets" full of caveats to that statement.

That first "bucket" pertains to the economic impact.

"This is still massive," he said, but the nature of it has shifted because, while the oil industry continues to drill a lot of wells, even though the prices are a lot lower, the wells are much more efficient. That's the good news.

The bad?

Margins have been squeezed. But even that isn't the end of the story.

"On the other hand, the lower prices," he said, "are a bigger boon to customers and end users."

The next "bucket," he said, is the environmental impact at the local site level.

This includes matters of methane, water disposal and the hydraulic fracturing



GEE

"Unconventional gas and oil resources are perhaps the single largest opportunity to improve the trajectory of the U.S. economy, at a time when the prospects for the average American are weaker than we have experienced in generations."

David Gee will present "Americas Unconventional Energy Opportunity: An Update" during the AAPG Global Super Basins Leadership Conference at the Hilton Americas Hotel in Houston to be held March 27-29.

itself. Here, Gee said, the goal is what he calls a "win-win" situation for both environmentalists and those in the industry.

"If you actually consistently apply mutually-agreed-to standards, you can do this very safely and in an environmentally-appropriate manner," said Gee.

This is true, even though the dynamic of the discussion has changed.

"Since this work had been studied originally" – and this was primarily done on the subject of hydraulic fracturing – "the issues have emerged on the seismicity, which was just becoming an issue, as well as the issue of methane," he said.

And here, Gee, again reiterated the importance of compromise – a topic he said will be emphasized in Houston.

"We will talk about how the same basic approach applies and that if you, again, take reasonably agreed-upon standards," all will benefit.

He also believes this is exactly the way the industry should go.

The question, of course, on the other side of the debate, is whether environmental groups, especially with their distrust of the Environmental Protection Agency under the current administration, will buy into the standards and participate in the formulation of these agreed-to standards.

"I think – and this an 'I think,' not an 'I know' – that on issues like seismicity and methane, you can get to win-win scenarios. The industry will complain a little bit about the cost, the environmentalists will complain a little bit about the efficacy of the standards, but you can kind of get something that everyone will be equally satisfied ... or equally dissatisfied ... with," said Gee.

The biggest gap in agreement, Gee said, is within the third "bucket." It's where the disagreement was before, where it is now, and where, do doubt, it will continue: the climate.

The question, as he sees it, is whether natural gas should be considered a bridge fuel or whether the industry should move right to renewables.

His answer?

"We need to refresh the analysis," he said.

The concern among many in the industry is that if the industry makes the commitment to building the infrastructure needed for gas, the cost would prohibit it from ever moving on.

"We found that's not true," said Gee.

His assessment is that even if the infrastructure is built, the economics indicate that the renewables will be so

cheap that they will negate those costs. With that in mind, he said it's still cheaper in the near term to build that infrastructure. As proof, he said, both gas and renewable prices have come down more precipitously since he and his team first made their calculations, and the trend will almost certainly continue.

The End of Coal?

On the subject of coal, Gee was succinct about its future and why, in fact, it has no significant part to play in the future.

"Yeah, it's gone," he said.

"It's just a question now of when the coal plants hit some triggering event, of needing some capital infusion, be it some big back-end scrubber or a revamp. Even the larger, more efficient coal plants can't survive that economically," he explained.

But what of the interest, the renewed passion behind coal coming from some sectors, especially the White House?

"That part of the dialogue by the administration hasn't helped anybody. It's background, unhelpful static," Gee said.

Ultimately, he said, what will end coal is reality, and it's only a matter of time.

"The economics are the economics," he said.

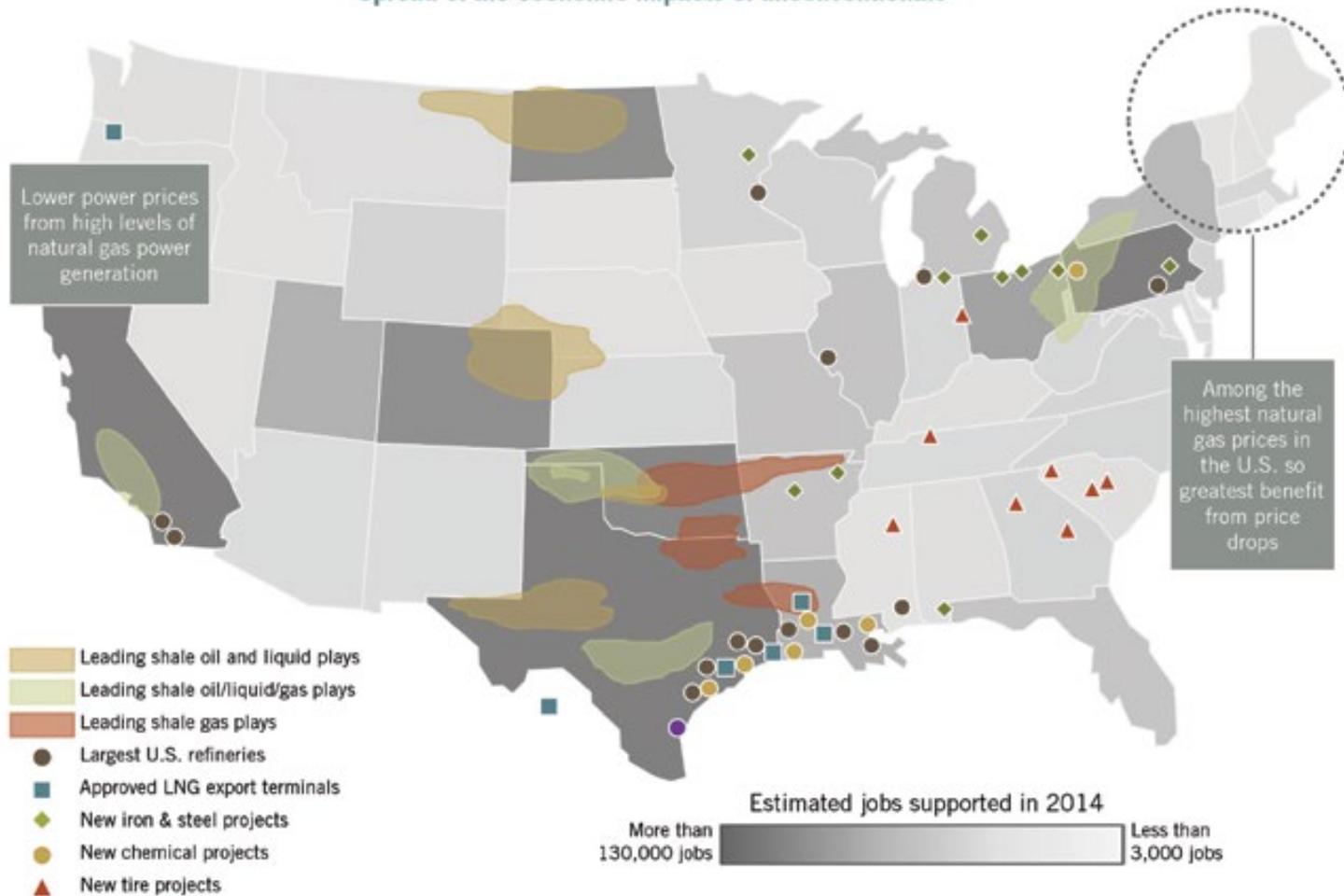
In Houston, Gee also will spend some time on what he calls the "divisive dialogue," for which both sides are to blame. He points to the recent debate around pipelines as one in which neither side compromises.

As for shale, though, he insisted, "If you do it right, with a set of standards, it's very, very safe."

"Larger producers are much better at compliance than the smaller operators," said Gee.

Continued on next page ►

Spread of the economic impacts of unconventional



Job forecast includes direct, indirect and induced employment. Projects shown on map are examples, not an exhaustive list. Image taken from the report "America's Unconventional Energy Opportunity" by Harvard Business School and Boston Consulting Group.

◀ Continued from previous page

It is these smaller operators' safety records, he believes, that have skewed the overall results.

"Not perfect, by any means," he quickly added, "but better."

Asked whether the various environmental groups are happy with the compliance of these larger groups, he laughed.

"I don't know if I'd go that far," he said, "but they are acquiesced to it. 'Happy' would not be the first word that comes to mind."

Every issue gets conflated, which means every issue is tougher to solve.

"My bucket number three is the one where there are the disagreements and so that clouds a little bit my bucket number two."

He wants "a clear line" between the two buckets.

"The battles on seismicity have come up. There's some denial by the industry," but he said the science is just about settled.

"The facts surrounding the water disposal causing seismicity are pretty compelling, but then how you mitigate that is not that expensive," he noted.

That's where agreement on standards is possible.

"But you need to create the right forum to do that; otherwise, people are entrenched in their own talking points," Gee added.

For now, one fact is clear, he said: "We do need to move forward with workable standards on methane and waste-water disposal."

As to whether there's hope about the divide, especially as it relates to the climatic issues in Bucket No. 3, he's not sure.

"It's almost theological, not political." ■

Homogeneity from page 9

centered on technical or 'below-ground' issues, such as estimating the quality of reservoirs or accessing and developing resources, which we still do, but today the non-technical or 'above-ground' factors increasingly influence the energy landscape," she added.

Schwarze said it is important for employees at all levels to understand how diversity and inclusion benefit the company, and most employees have diversity action plans as a part of their annual evaluation.

"What started with geopolitics now encompasses managing diverse perspectives on everything from limited access to resources, complex fiscal terms, challenging infrastructure needs, supply chain complexities, and a vast array of expectations, local content requirements and human capacity," she said. "We need all of our staff, including subsurface, to be aware and participate."

Tackling Homogeneity

For Chris Jackson, a professor at Imperial College of London, professional associations like AAPG should follow the lead of companies like Chevron and take diversity more seriously.

His presentation, "Recognizing and Rewarding Excellence without Blinkers: a Close-to-Home Case Study," focused on the limited recognition that professional societies give women and minorities.

Jackson, a son of immigrants from the West Indies, grew up in the industrial town of Derby in the United Kingdom. He studied geology because he liked dinosaurs, earthquakes and being outside,



JACKSON

"We have a strange view of diversity. To make a diverse group, we often say we need a woman and someone who is not white. What about disabilities? Or sexual orientation? Or socioeconomic status?"

crediting a large part of his professional success to the work ethic his parents instilled in him as a child.

Jackson worked and studied in North Africa, South America, Europe and the United States, and he became involved in the Geological Society of London and AAPG. He noticed early on that there are few other black geologists in his professional circles.

"I go to many of the major research conferences typically held in Europe and North America, and there aren't very many people who look like me," he said, "Fortunately, I'm fairly thick-skinned and don't get intimidated by it, with my interactions with fellow geoscience being invariably positive."

Jackson increased his involvement with AAPG, participating on several committees and serving as senior editor of the Bulletin. In 2013, he toured the United States as a Distinguished Lecturer.

Though Jackson appreciates the opportunities AAPG programs provide to him and others, he sharply criticizes their homogeneity and has recently let his membership lapse.

"In my opinion, the Distinguished Lecturer (DL) program has an appalling record at recognizing diversity. When I looked at the historical record of DLs from the 1940s on, of the 670 awardees less than 10 percent have been women,

with the first female recipient seemingly being in 1982. I can't even bring myself to work out how many minority recipients there's been. Why is that? Why does AAPG have such a poor record of recognizing excellence amongst all of its diverse members?" he asked.

"In fact, the same criticism could be leveled at the list of AAPG Honors and Awards. You could just say there's not that much diversity out there, such that the awardee list reflects reality, but that's just not true," he said. "There's an issue here. We are not recognizing everyone."

Jackson said that while many AAPG members recognize the problem, some appear unwilling to do anything about it.

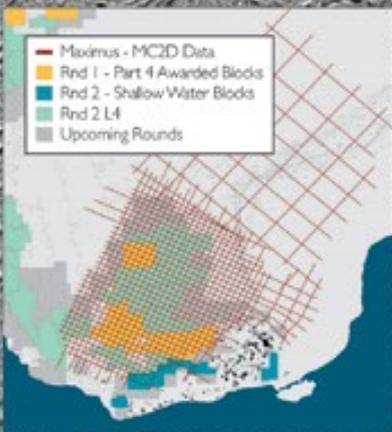
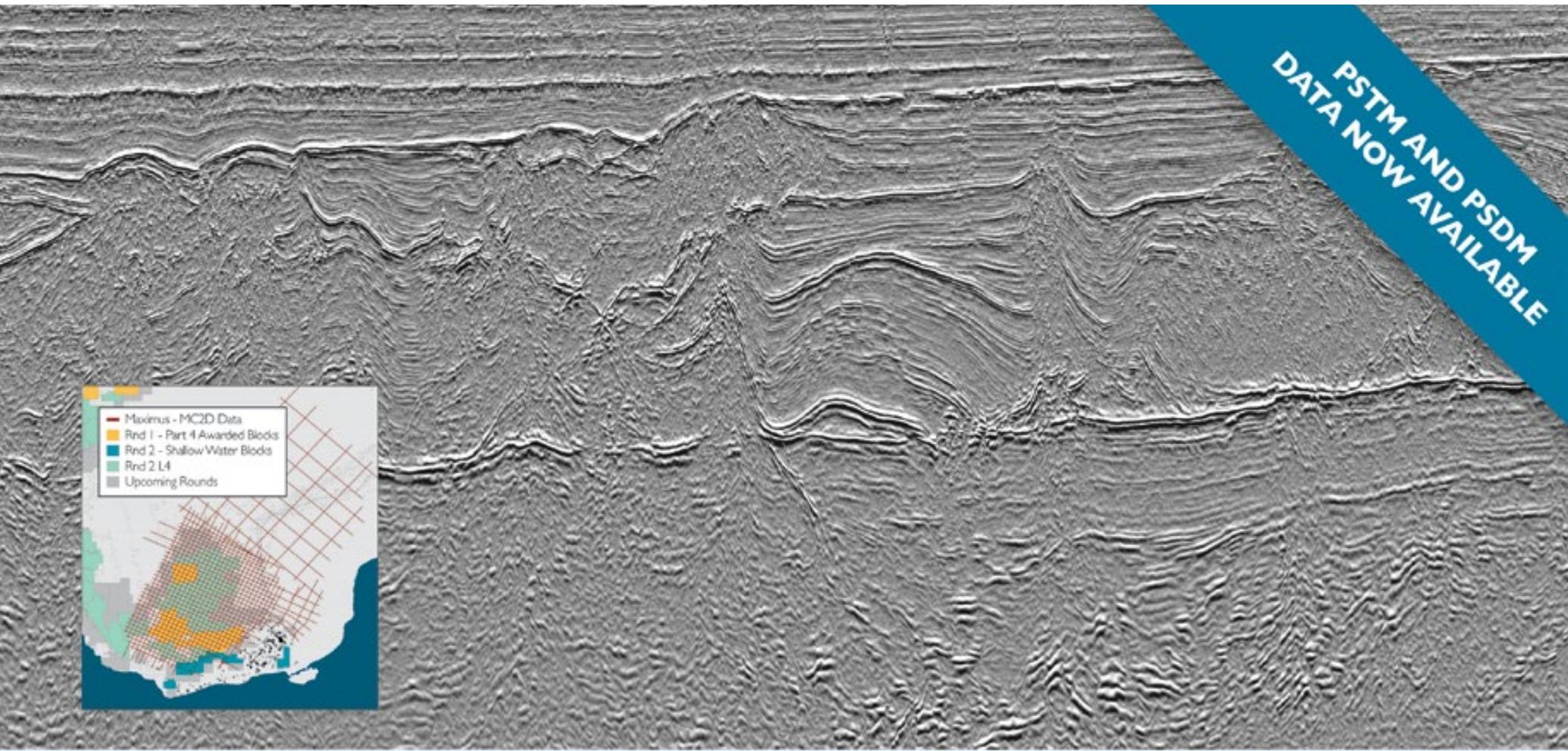
"AAPG needs to self-recognize this is an issue and make concrete plans to address it," he said.

Jackson suggests publishing a list of all Distinguished Lecturers and all honors and awards recipients and identifying how many women and minorities have been selected.

"We can use that list to motivate people to think more broadly," he said.

Because nomination forms do not, for example, ask about nominees' race or sex, he said those who nominate candidates might consider highlighting that nominees come from a population historically under-

See Experience, page 15 ▶



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Mexico's Sureste Basin

An archetype of a 'super basin'



Talos drilled Zama-1 with the Enasco 8503 rig. Photo courtesy of Enasco.

The resurgence of the Permian Basin in the United States led directly to the concept of the "super basin": a mature basin that can be rejuvenated to produce as much or more oil and gas than it has so far.

Another archetype for super basins lies 1,000 miles southeast of the Permian, in the onshore/offshore Sureste Basin of Mexico.

This is the home of the supergiant Cantarell oil field, discovered in 1976, which hit peak production of 2.1 million barrels a day in 2003. Since then, Cantarell's output has steadily declined.

It's also the basin where operator Talos Energy recently reported a major crude oil discovery.

In July, the company said its Zama-1 well found an accumulation of up to 2 billion barrels of oil after drilling to about 11,100 feet offshore in 546 feet of water, marking what it called "the first offshore exploration well drilled by the private sector in Mexico's history."

Talos Energy holds a 35-percent interest in the well, Sierra Oil and Gas 40 percent and Premier Oil 25 percent.

At this point, super basin-status for Sureste looks like a legitimate call, said Mark Shann, subsurface director for Sierra Oil and Gas in Mexico City.

Prospectivity of the Sureste

Using numbers for exploration success and total production, a future outlook for the Sureste can be estimated, he said.

"We can use the creaming curves, or the discovery curves, from the U.S. Gulf of Mexico to make a prediction," Shann said.

"In less than 200 meters of water there have been 230 discoveries finding 40 billion barrels of oil equivalent, and 800 exploration wells. That excludes Cantarell. If you add Cantarell, the number goes up to 55 billion boe," he noted.

Success rates and discovered-reserve numbers for the deepwater have been reasonably proportional to

"Talos Energy's Zama-1 well is 'the first offshore exploration well drilled by the private sector in Mexico's history.'"

the shallow-water drilling, so it's fair to think the Sureste could put up a future oil production total comparable to past production, he said.

"All you need to do is find another couple of things and you're right back there," Shann said. "We have identified a structure that is at least as big as Cantarell."

A key concept is that Sureste's prolific onshore and shallow-water formations are also present in deepwater plays.

"It's the same petroleum system. We know from petroleum seeps and our own mapping that the same formations extend into the deepwater," Shann said.

Because today's oil industry has much-improved seismic imaging capability plus a wealth of information and experience to draw upon, Shann thinks the Mexican side of the Gulf of Mexico will develop more rapidly than did the U.S. side.

Sierra Oil and Gas has already accumulated a significant amount of data to assess prospects, he said.

"We've got a dataset where we can look under the salt canopy. It is changing our view of the (basin's) prospectivity," he explained.

The company's data resources include 2,000 wells with logs, 800 wells with core data, 60 wells with source rock information and 500 wells with pressure-volume-temperature information, plus extensive 3-D seismic, Shann said.



The Sureste Basin will be a topic included in a presentation to be given by **Ivan Andrea**, CEO of Sierra Oil and Gas, "Mexico, Tampico Mizantla Basin and Sureste Basin," at the AAPG Global Super Basins Leadership Conference to be held March 27-29 at the Hilton Americas Hotel in Houston.

"Once you get your hands on that data, you can use it to drive your exploration campaign. As a company dedicated just to exploring Mexico, we have the luxury of only doing Mexico so we have the time and the focus to do the work," he noted.

Anatomy of a Super Basin

Established producing formations and known source rocks give super basins much of their allure.

"You don't have to go after virgin source rock. There is plenty of low-hanging fruit in the super basins," said Pete Stark, executive director of upstream research for IHS Markit and co-author of the super basin concept.

Also, new technologies – especially horizontal drilling – can open up previously non-producing or low-producing formations in hydrocarbon-rich super basins. Opportunities vary with geology, and while super basins are similar, no two super basins are exactly alike.

"The Permian Basin is a magical place," noted AAPG President Charles Sternbach. "A lot of the innovation from the Permian is, if you drill a dozen wells, why not drill hundreds of wells? For me, what's really exciting is the upscalability," he said.

Sternbach contrasted that basin with the North Sea, where infrastructure additions and improved imaging will make a difference, and with the very mature Appalachian Basin, where new approaches including unconventional development are required.

"The Gulf of Mexico is also a super basin province. It has multiple

source rocks. It has billions-plus barrels produced and billions-plus left. Major infrastructure, multiple plays, multiple pays," he said.

Sierra Oil and Gas maps "everything from basement to seabed" to assess prospects in the Sureste, Shann said. With seeping oil on the water's surface and prolific source rocks buried below, success depends on the presence of both traps and significant hydrocarbon accumulations.

"The structures we see are very high structures, kilometers high. The question of how much you've retained is going to be the issue," he said.

If the Zama discovery well is an indicator of Sureste's deepwater future, the industry could have multiple attractive structures to try.

Regulatory Factors

"The question then is, 'How fast can you drill these things?'" Shann said.

How fast wells can be and will be drilled is a question in all super basins. Economics and price are significant factors, and so are regulation and geopolitics.

"There are critical qualitative and risk aspects in play for various super basins. Price is going to be a big issue. Policies that are in place or will be put in place also will affect the future of super basins," Stark said.

Development in already-producing onshore super basins needs a different regulatory approach from the frontier exploration process of finding a large structure, drilling a successful test and then drilling a confirmation well, according to Stark.

"The regulatory environment for traditional conventional exploration doesn't work well when you need to drill a large number of wells in a timely manner," he said.

Stark thinks macro-economics could, and should, affect policies and ease regulations for super basin development.

Economic Impact

He said the impact of horizontal technologies – primarily in North American super basins – has reduced global oil and gas prices and is now saving energy consumers worldwide about \$7 billion a day.

Shann said he worked at BP for 30 years before joining the small group of professionals that founded Sierra Oil and Gas in 2014. He lived in 13 countries for more than two years each in his BP career, including Mexico and countries in Latin America.

He considers the company's current area of focus to be a world-class region for oil and gas prospecting.

"I've always wanted to come back. I have been amazed at the quality of the source rock," Shann said. "It stands out to me, globally, as one of the key places on the planet to explore."

Many people in the industry thought the offshore Sureste Basin "would not be as prolific as the U.S. Gulf of Mexico, and that has not been the case," Shann observed. It's turning out to be a highly favorable province – for companies willing to do the spadework.

"There are no shortcuts in Mexico. You absolutely have to be a data hound to be successful," Shann said, adding, "I don't think Mexico has any shortage of information – its oil exploration history dates back to 1869." 

Searching for Energy Resources with Network Analysis

Methods used by large companies to target marketing to individual consumers are being applied in the search for energy and mineral resources.

The sheer amount of data of all kinds being generated and stored is unprecedented. Researchers are exploring ways to sift through massive amounts of information to tease out patterns that may have been overlooked or not considered before, explained Robert Hazen, executive director of the Deep Carbon Observatory at the Carnegie Institution for Science in Washington, D.C.

Hazen is co-author of a new study published in *American Mineralogist* that examines the use of network analysis in the search for new mineral species. The mineral hazenite is named for him.

"It's similar to when you order something from Amazon or Netflix," Hazen said.

The companies have access to your recent purchases, plus other information like ZIP code and credit use. By analyzing shopping patterns, "They see there's a high probability you will like this product," said Hazen.

"There may be some subtle connections, like activities you've shared with friends on social media. It's a very powerful driver for targeted marketing," he said.

"The techniques apply equally well to the natural world," he added.

Application to Oil

"Mining and petroleum companies have been doing this for decades, but computers can tease out correlations we didn't see before," he said.

Explorationists have tons of data relating to distribution of resources, depth, stratigraphy, microbial and biological information, trace

elements and much more.

"You look for very high dimensional relationships," he said.

"If I'm looking for oil and I recognize sediment, that's a one-to-one correlation. We can look at many more variables simultaneously. There may be some complicated non-linear combination that can help maximize our chances of discovery."

New network analysis visualization methods "can be very powerful in showing trends that might not be obvious to the human mind," Hazen said.

"The idea is clearly applicable to energy exploration."

Hazen said computerized analysis techniques are being used by medical professionals to gain more accurate diagnoses, and by governments to track possible terrorist activity.

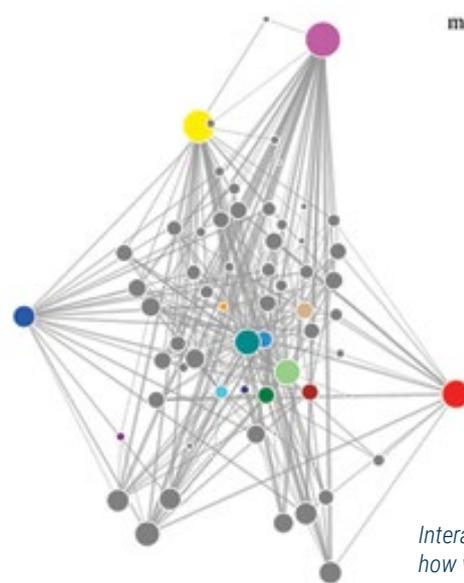
The technique goes beyond traditional geology by amassing data about how and where minerals have formed and using that information to help find other deposits, according to the report by Hazen, lead author Shaunna Morrison, also of the Carnegie Institution, and several other colleagues.

Mineral Challenge

The researchers have launched a project to find and identify new carbon-bearing minerals whose existence has been predicted. Ten new minerals already have been discovered through the project, which invites researchers and amateur collectors worldwide to join the search.

Hazen said models indicate at least 145 "missing" species are yet to be discovered.

Hazen said the project, which can be explored at mineralchallenge.net, has been



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- alkaline intrusions
- felsic phanocrystalline intrusive rocks
- felsic porphyroaphanitic intrusions
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- marine mafic extrusive rocks
- subaerial felsic to mafic extrusive rocks
- marine felsic to mafic extrusive rocks
- clastic sedimentary rocks
- carbonate rocks
- Chemical-sedimentary deposits
- regionally metamorphosed rocks
- surficial processes and unconformities

Interactive graphics at dtdi.carnegiescience.edu show how visualizations can be used to explore networks.

a "transformation in the mineral world. The mineralogy community seems to love it."

Network visualization techniques can help point to specific locations where rare, undiscovered minerals are likely to be found.

In addition to locating new minerals, the Mineral Challenge website reports that the research into carbon mineral evolution is providing a fresh perspective of Earth's history by addressing suites of new questions, which could influence Earth materials research and education:

- ▶ What were the earliest carbon-bearing minerals on Earth?
- ▶ Did carbon-bearing minerals play a role in the origin of life?
- ▶ How did the evolution of life affect the evolution of carbon minerals (and vice versa)?

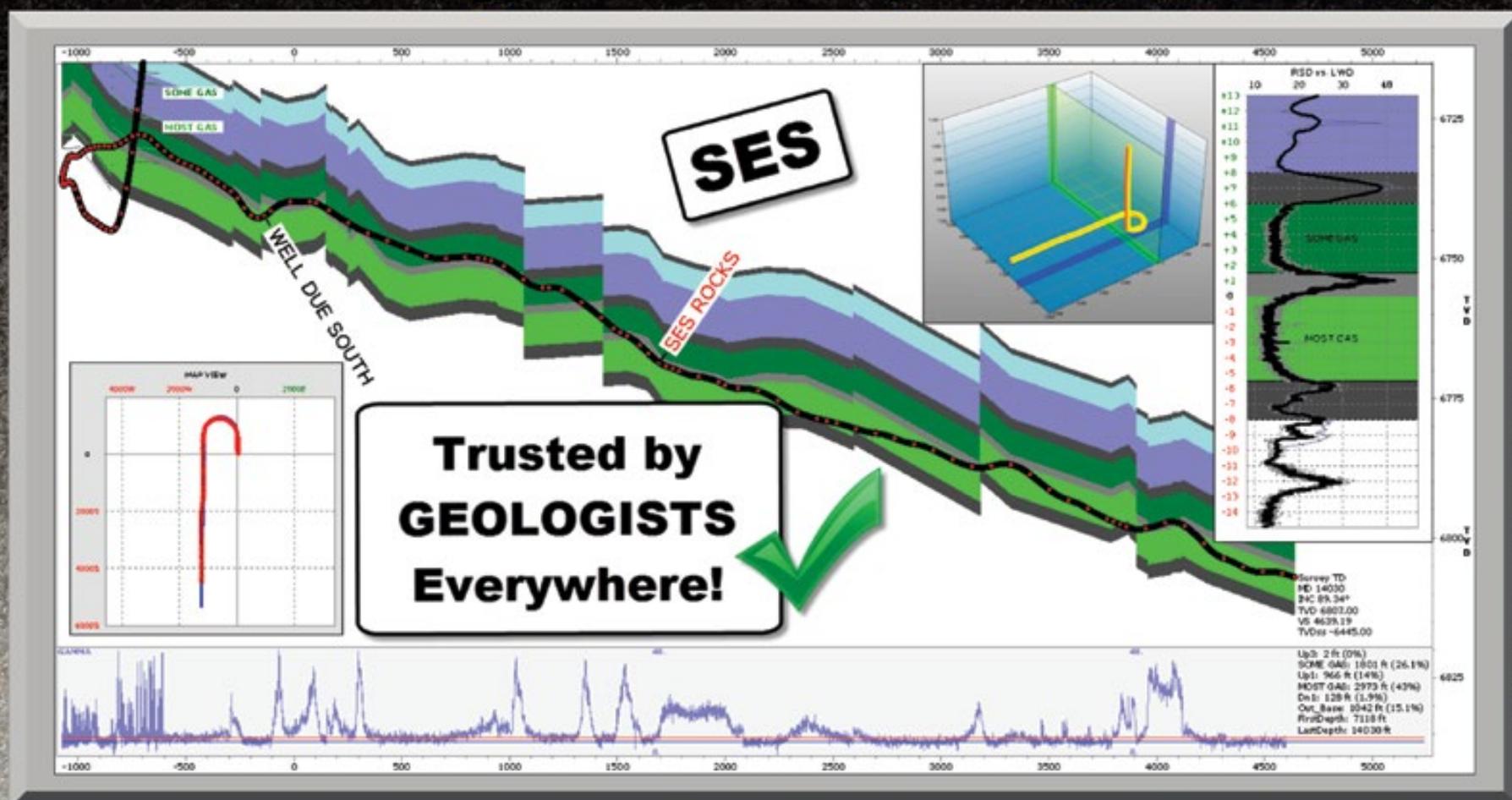
- ▶ Are there carbon-bearing minerals on the moon and Mars?
- ▶ Are humans affecting the diversity and distribution of carbon-bearing minerals?

Hazen said a new undertaking, the Deep Time Infrastructure Project, involves some 50 collaborators and is aimed at gaining new insights regarding Earth's evolving oxidation states of the atmosphere, oceans and near-surface environments.

He said analytics promise a "very dynamic future ... it will transform science."

While some discoveries may not have economic applications, "If we understand distribution and diversity, we can make better predictions and better husband the resources we have. It's a tremendously important part of any approach to earth resources." [E](#)

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Gulf of Mexico: Where Big Fields Are Getting Bigger



BP's Na Kika platform in the Gulf of Mexico. Photo courtesy of BP.

“When you combine the U.S. and Mexico, onshore and offshore, the Gulf of Mexico basin is one of the world's most prolific hydrocarbon super basins. Over 250 billion barrels of oil equivalent have been discovered to date, and almost 20 percent (currently 18 percent) of U.S. oil production comes from the Gulf of Mexico.”

That's Cindy Yeilding, vice president of exploration and appraisal at BP, speaking about the petroleum power and potential of the Gulf as a preview to her upcoming presentation at the AAPG Global Super

Basins Leadership Conference in Houston, which will include discussion of the region's production history and the geologic trends, innovation, and, yes – even failures associated with the region.

The realm of the Gulf of Mexico is not just important to the United States.

“We will also highlight the Gulf of Mexico ... and the promise it holds for Mexico,” she said.

Life from the 'Dead Sea'

Industry has been exploring offshore

possibilities in the U.S. Gulf of Mexico since the 1930s, when the first wells were drilled in a few feet of water. It was an exciting time, especially in the late '40s.

Unfortunately, however, much of the early “colorful history,” as Yeilding described it, has been lost.

(The U.S. Department of the Interior and the Bureau of Ocean Energy Management has done a good job reconstructing the Gulf of Mexico's resume in its study entitled “History of the Offshore Oil and Gas Industry in Southern Louisiana.”)

“Exploration in the deepwater U.S. GoM,”

Yeilding said, “dates back to the late 1970s,” and like any exploration program, there have been failures, but also perseverance and tenacity.

And a watershed moment.

Yeilding pointed to Shell and BP's discovery of Mars in 1989, a project about 130 miles southeast of New Orleans. Initial cost of the development was pegged at about a billion dollars.

It's been a good investment.

According to the website technology.com, Mars produces approximately 21,000 barrels of oil and 25 million square feet of gas. It was and is the largest Gulf of Mexico discovery in more than 25 years and confirmed the presence of a world-class hydrocarbon source and well-developed clastic reservoirs.

“That was the turning point for developers,” Yeilding said.

Yeilding concedes that while many in the industry flocked to the region afterward and made significant discoveries following Mars, there was also a series of expensive dry holes. This was about the time many in the region started characterizing the Gulf of Mexico as “the Dead Sea.”

The relationship between the industry and the Gulf of Mexico has always been a bit on the complicated side.

“We have a love/hate relationship with the salt present in much of the GoM. We battle the seismic imaging challenges created by salt, but we love the salt-related structural complexity that sets up the hydrocarbon system for much of the basin,” she said.

Continued on next page ►

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YEILDING

“While there have not been major exploration successes – or ‘elephant-sized’ discoveries – in the U.S. recently, there are still twinkles in the explorers’ eyes, and the basin holds promise for new plays in both the U.S. and Mexico.”

◀ Continued from previous page

Yeilding said that industry persevered in the deepwater because it developed new exploration concepts focused on older and sub-salt stratigraphy.

“We invested heavily in the development of 3-D seismic at scale and advanced 3-D seismic imaging techniques, which dramatically improved our imaging beneath the salt. Eventually this led the way to major sub-salt discoveries such as Thunder Horse, Mad Dog and Atlantis,” she said.

Untapped Promise

As for the future, Yeilding said the challenges in the Gulf are similar to those throughout the industry.

Specifically, in the Gulf of Mexico, dozens of operators have left, moving their investments to onshore fields or other basins around the globe.

“In the current lower oil price environment, many companies have been tightening their belts and paring back their exploration programs,” she said.

Additionally, co-ownerships, as well as suppliers collaborating to reduce cost, have also increased efficiency.

Yeilding calls for a new understanding of the shift by “creating a fiscal and regulatory environment that helps spur development and production in the Gulf of Mexico.”

Specifically, she calls for resetting royalties back to the traditional rate of 12.5 percent.

“About a decade ago, in response to high oil prices, U.S. deepwater royalty rates were raised by 50 percent, and many new lease terms were shortened,” said Yeilding.

Because of the subsurface complexities of the deepwater, she said, “We would also like to see all leases carry an initial lease term of 10 years, which is often how long it can take to develop a lead into a drill-able prospect.”

For all the difficulties and tightening of margins, she is not dissuaded.

“The basin still holds lots of promise. Recent advances in seismic imaging have allowed companies to gain more accurate images of the subsurface. Technology has helped with the ability to develop fast paced tie-backs, and we are seeing a lot more of those projects competing for capital in the U.S.,” Yeilding said.

For example, the Mexican side of the basin is open – which she calls “enticing” – and has had significant discoveries to date and promising discoveries on the horizon.

“While there have not been major exploration successes – or ‘elephant-sized’ discoveries – in the U.S. recently, there are still twinkles in the explorers’ eyes, and the basin holds promise for new plays in both the U.S. and Mexico,” she said.

Big Fields Get Bigger

And while the Gulf of Mexico will be the focal point of the presentation, specifically, Yeilding is excited about super basins in general, for more than 60 percent world’s oil reserves and resources come from giant oil fields. These basins are where the adage “big fields get bigger” comes to fruition.

“A small increase in recovery, or an additional untapped reservoir, can have a significant impact on production and reserves,” she said.

“We’ve experienced this in several fields in the GoM,” Yeilding concluded, “including our Mad Dog field. Mad Dog was initially estimated at four billion barrels of oil in place, but recent appraisal drilling and new geophysical technologies demonstrate that the field likely holds over 5 billion barrels in place.”

Cindy Yeilding, vice president of exploration and appraisal for BP, will present “Gulf of Mexico Offshore Evolution of Past, Present, and Future Plays” at the upcoming AAPG Global Super Basins Leadership Conference to be held March 27-29 at the Hilton Americas Hotel in Houston.

often say we need a woman and someone who is not white. What about disabilities? Or sexual orientation? Or socioeconomic status?”

Different Life Experiences

Finding new ways of thinking was the focus of the presentation offered by geologists Linda Lerchbaumer and Chloé Asmar, who work together at OMV Upstream in Vienna. During “Diversity in Central/Eastern Europe as Seen from both the Inside and the Outside,” they discussed perceptions and realities of life in Central Europe and the Middle East.

Lerchbaumer grew up in a small mountain village in the south of Austria. Despite having a long tradition in tourism, the town had little exposure to people from different cultures. She first started to think about the different world outside as a child in the early 1990s when refugees who fled from the Yugoslav Wars came to her hometown.

“I remember realizing for the first time that there’s another world out there that’s probably not as beautiful as the world I’m living in. At the same time I was curious

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Experience
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recognized by AAPG and other professional associations.

Jackson emphasized that recognizing people with diverse backgrounds provides an impact far beyond the individual recognized.

“Think about what those awards mean for people, not just the awardees themselves but to the communities they represent,” he said. “You can argue about whether an award means you are good or not, but it helps you to serve as a role model for others.”

Jackson said professional associations should add diversity to their ethics and code of conduct. He also suggested putting out a position paper on where the Association stands and where it wants to go.

He applauded AAPG’s special interest group Professional Women in Geosciences (PROWESS), which highlights that key role that women play, but he emphasized that there are many types of diversity

“We have a strange view of diversity,” he said. “To make a diverse group, we



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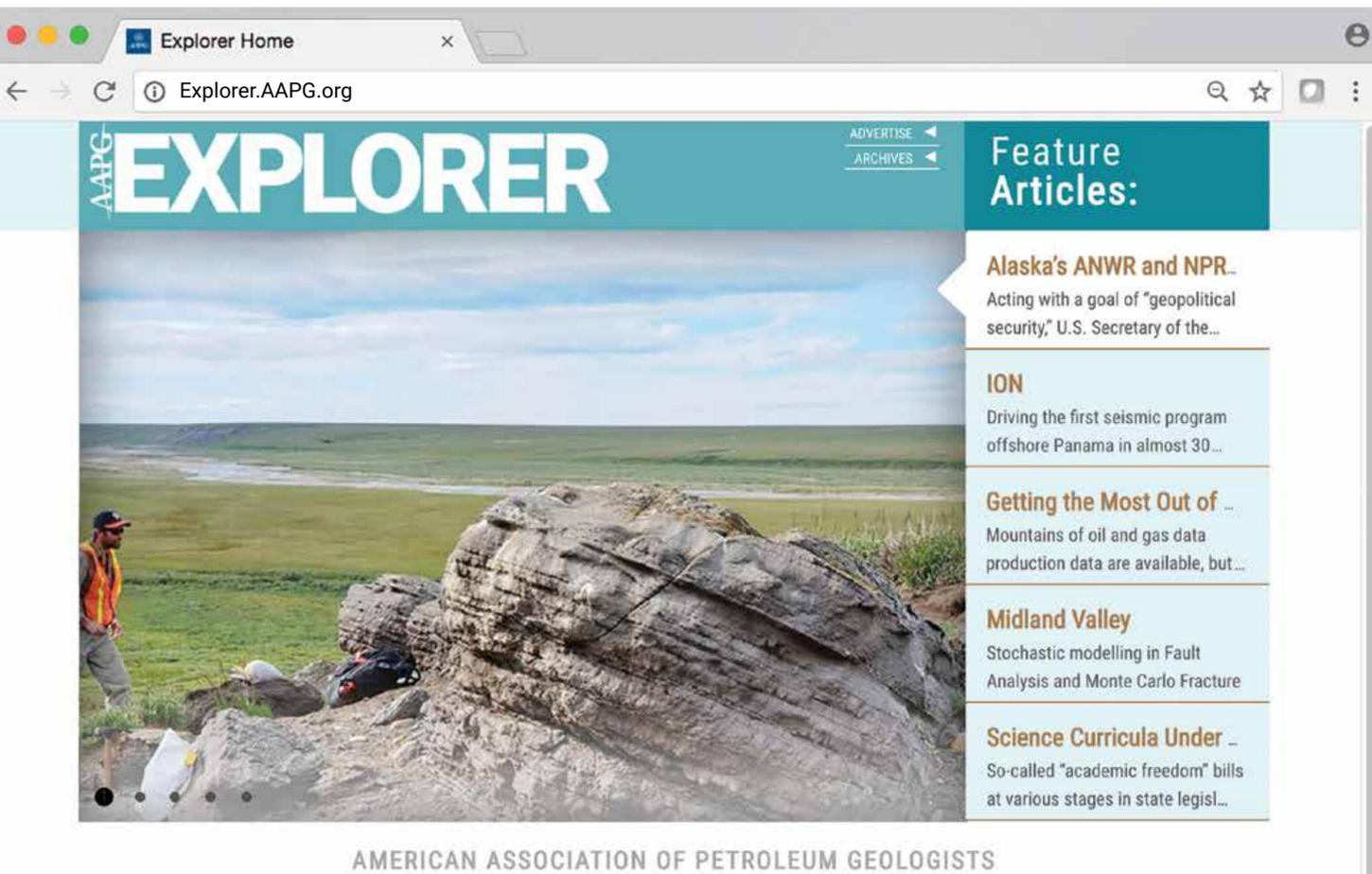
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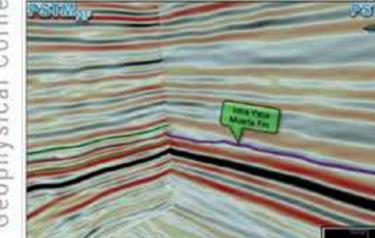
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Historical Highlights



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Vienna

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and had more sympathy for them than being afraid about these foreign people being around," she said.

During her doctoral studies in an international research facility in Germany, Lerchbaumer worked with people from other parts of Europe and Asia and learned the benefit of actively interacting with them.

"When you are working with people from different backgrounds you have to spend time together, talk to each other to understand the different ways of thinking, working and living. Soon, things become easier and even amusing: you do not only share your different experiences and start to look at scientific problems from more diverse points of view, you also share



GILLIS

"At Aramco, we find that diversity leads to innovation, and innovation provides a competitive edge."

dinners and introduce your cultures to each other," she said.

Asmar's earliest exposure to different cultures started at a young age while attending an international school. Her real multicultural experience started during her undergraduate studies in her home country of Lebanon. She later had the opportunity, through OMV, to pursue her graduate studies in earth sciences in Vienna, where she then started her career in the industry.

"Austria was never on my radar," she said,

noting that historically, Lebanon has more ties with France than with Central Europe.

"When I made the decision to move to Vienna, I had to familiarize myself with Austrian culture, beyond the Waltz, Mozart and the clichés we hear about back in Lebanon," she said.

Upon arriving in Vienna, Asmar said she was surprised about how little Austrians knew about Lebanon and the Middle East.

"I thought people would be as curious about my country as we are about Europe in general," she said. "Our education is oriented toward the West. I expected that people

here would be a lot more exposed to Middle Eastern history and economics further than the current state of geopolitical affairs.

Many times I would get a lot of interesting questions such as: 'being a woman, are you oppressed back home?' I would hear stereotypes that I didn't expect, especially not in the globalized world we live in today."

Encountering stereotypes motivated Asmar and fueled her determination to help promote the understanding of Lebanese and Middle Eastern culture.

"I want to demystify some of the things that you see on the news," she said, "I want people to appreciate me for being Middle Eastern."

Lerchbaumer noted that she too thinks that it is important to see the individual instead of stereotyping people.

"I simply want to be myself, Linda, not the female Austrian geologist from the countryside," she said.

Both women recognize that their education and profession give them an appreciation for diversity that others might not have.

"We're in an industry that gives us the privilege to work in diverse environments," Asmar said. "Currently, diversity is being challenged worldwide. Countries are dealing with pressing issues on immigration and asylum seeking. Where we are is almost an exception to the world. We need to share what we have learned.

Lerchbaumer agreed.

"Our industry has been diverse for a long time, but we are also in a different socioeconomic level. We cannot really compare it to, for example, small family run businesses in Austria. It's just not on their agenda. They have different worries and problems," she said.

Lerchbaumer also recognized that overemphasizing diversity could backfire.

"As soon as you start pushing on being diverse and saying that we have to include this or that group of people, we artificially categorize people and make them sound and – even worse – feel different," she said.

Asmar said the best way to avoid resistance to diversity is to be pragmatic.

"Diversity should not be addressed as a philosophical topic. We should be emphasizing the important role of all diversity topics, as a good business decision," she said.

"We should reach a stage in our industry, when the need to talk about diversity would not be something special. People are different, and differences often pose challenges. Nonetheless, the beauty in that is (that) it allows us to keep expanding our horizons, improving and staying curious about the world we live in, especially in the times ahead," she said.

Asmar noted that the understanding of diversity should ultimately go beyond society.

"We are not just talking about nationality or culture or gender. It's the way you think and communicate. Those are key points to keep in mind. In a scientific field, if you don't make sure that you cover all perspectives, you are not doing your job as best you can as scientists. This comes through interacting with people. If we are not actively embracing our differences, we may miss out on information that's very relevant and important."

Diversity Breeds Innovation

Gretchen Gillis, a geologist and panel co-chair and longtime AAPG Member, agreed.

"I have witnessed the benefits of diversity at every stage of my career, starting with diversity of thought among those educated in different universities in my first exploration job," she said. "Later, at Schlumberger, I experienced the benefits of an extraordinarily diverse workforce in

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◀Continued from previous page

terms of nationalities, cultures, educations, and experiences working together on multidisciplinary assignments.”

Gillis currently works for Aramco Services Company (ASC), the U.S. subsidiary of Saudi Aramco, based in Houston.

“My colleagues represent a broad spectrum of age, culture, and educational backgrounds, including Saudi Aramco employees on assignment,” she said. “My job involves travel to Saudi Arabia, where I see increasing diversity in the workforce – many young women are choosing careers in geoscience, engineering and computer science.”

Gillis noted that workplace diversity goes beyond gender, race and ethnicity; age and life experience are important factors as well. She noted how Saudi Aramco developed its Young Leaders Advisory Board to develop dynamic teams with different backgrounds and cultures.

“At Aramco, we find that diversity leads to innovation, and innovation provides a competitive edge,” she said. She added that organizations find more rigorous solutions when diverse teams address exploration and production challenges.

“Senior geoscientists who have worked in many petroliferous basins are able to apply their knowledge of analogs,” she said. “Young geoscientists are familiar with the newest concepts in science and can be fearless in applying new technology. Diversity breeds innovation and diversity makes good business sense.”

She noted how a quote from Chris Jackson published in a recent article published in The Guardian caught her attention.

“(Jackson) stated that he knows of ‘no other black, full-time, earth science academic in the UK – or in fact, Europe or the U.S.’,” she said. “I find that distressing because our science is missing out on the talents of a large group of people, just as it did when there were so few women in the mix.”

The Goal

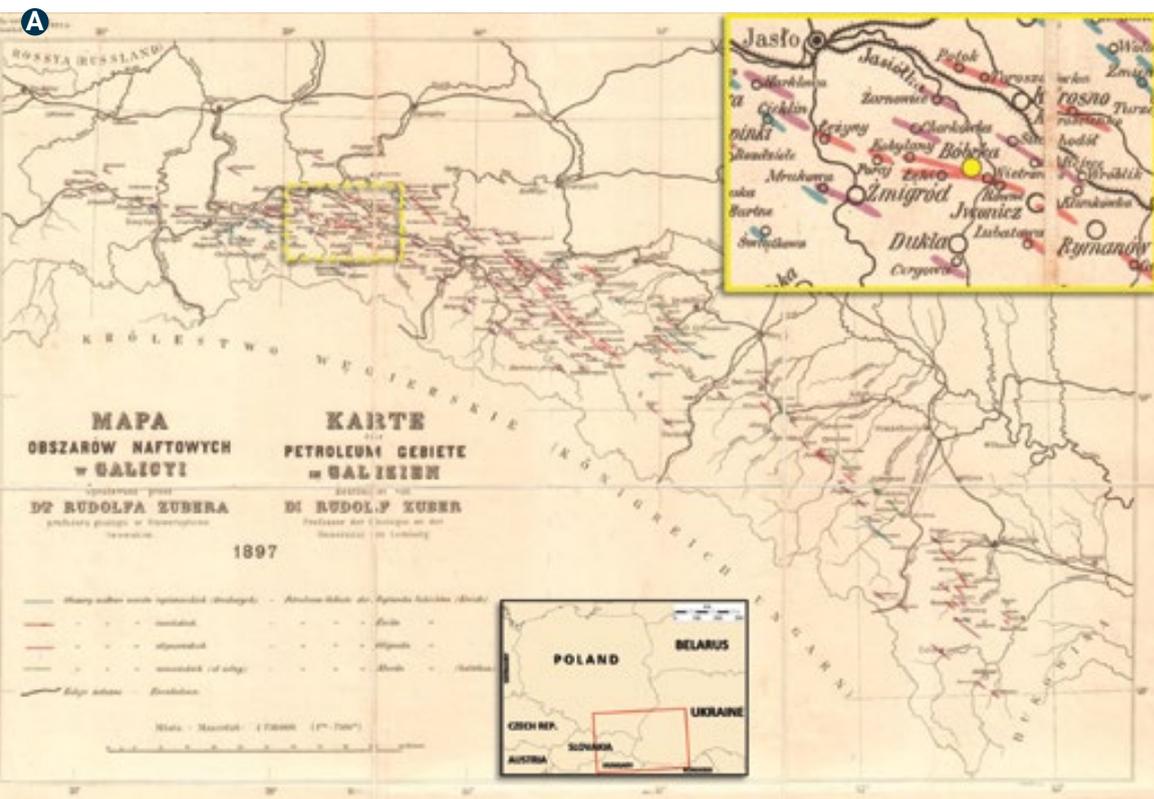
Jackson said he enjoyed the panel, though he disagrees with the use of the term “bottom-line benefits.”

“You shouldn’t have to sell diversity to people. I think it’s odd that we have to have this conversation around the financial driver for it. We should embrace diversity because we want to be decent human beings,” he said.

Asmar said she is looking for hope for the future.

“We have to reach a stage where we don’t talk about diversity anymore. I would like to see if other speakers have had an experience where it was just part of their daily life to be in a diverse environment. That’s the goal,” she said. 

Historical Highlights



The Birth of the Modern Oil Industry in the Northern Carpathians

Various practical applications of oil, gas and other forms of hydrocarbons have been known in different countries and on different continents for centuries. The modern oil industry, however, with oil and gas being used as an effective and economically viable source of energy, began relatively recently, in the mid-19th century, with the discovery of an effective refining process to transform crude oil into lamp oil and the invention of safe and effective oil lamps. These early developments, plus the increased demand for oil (and then gas) by the energy sector, were quickly followed by rapid advances in drilling technologies, petroleum geology, geochemistry and geophysics.

As is very often the case in other areas of invention, the birth of the modern oil industry is also a good example of the so-called “parallel thinking,” i.e. of developments or discoveries that were independently achieved at approximately the same time by various people in different places. By the early 19th century, the required critical mass of knowledge and experience had been reached that – coupled with an increasing demand for hydrocarbons – allowed for the rapid advance of oil and gas exploration and production technologies.

The first documented well drilled to produce petroleum, the Bib-Eybat well, was spudded in Baku region (then part of Russia) in 1848. The best known name associated with the birth of the modern oil industry, however, is “colonel” Edwin Drake, who in 1859 drilled his famous well in the Oil Creek Valley in Pennsylvania that led to the first oil boom in the United States.

Simultaneously, oil prospectors were equally busy in the Carpathians. The northern segment of this orogenic belt, presently located in southeast Poland and western Ukraine, belonged in the late 19th and early 20th century to the most prolific hydrocarbon provinces and, for a short period of time, was the third-largest oil-producing region in the world. Oil and gas fields are located within the Outer Carpathian thrust sheets, predominantly composed of Cretaceous-Paleogene deepwater turbidites. Fine-grained clastics, rich in organic matter, form excellent source rocks, and coarse-grained sandstones form good-quality reservoirs. Surface hydrocarbon

occurrences (oil seeps and gas exhalations) have been known in the Outer Carpathians for centuries, with earliest published records dating back to the 16th century.

Full-scale commercial mining operations began in the mid-19th century. They first focused on oil, and later also on ozokerite (earth wax) and natural gas. It came about because of the hard work and persistence of Polish pioneer Ignacy Łukasiewicz and his vision of the future industrial development of his home country.

Early Life

Łukasiewicz, together with Edwin Drake and other mid-19th century figures, can be regarded as one of the founders of the world's modern petroleum industry. His life was intimately linked to the complex history of Poland in the 19th century, which until 1918 did not exist as an independent country after being partitioned in the late 18th century among Russia, Prussia and Austria.

He was born in 1822 near the city of Mielec in southern Poland. His father, a member of the local nobility, participated

in the 1794 Kościuszko Uprising – one of numerous efforts to resurrect independent Poland. After completing his basic education, Łukasiewicz began his professional career as a pharmaceutical assistant, first in Łańcut, and later in Rzeszów.

During this period of his life, Łukasiewicz developed a keen interest in chemistry that determined his future professional activities. His time in Łańcut and in Rzeszów also shaped his political profile: he became involved in various patriotic activities under the guidance of Edward Dembowski, one of the leaders of the unsuccessful 1846 Kraków Uprising, and was arrested and imprisoned. He was released after 18 months in prison in Lwów, in the western Ukraine. He always remained a suspicious figure in the eyes of Austrian officials, though.

The next and probably most important step in his career was his employment at the “Under the Golden Star” pharmacy in Lwów. His professional achievements as a self-educated chemist prompted local authorities to give him permission to enroll for graduate studies in chemistry and pharmacy at the Jagiellonian University in Kraków. After moving

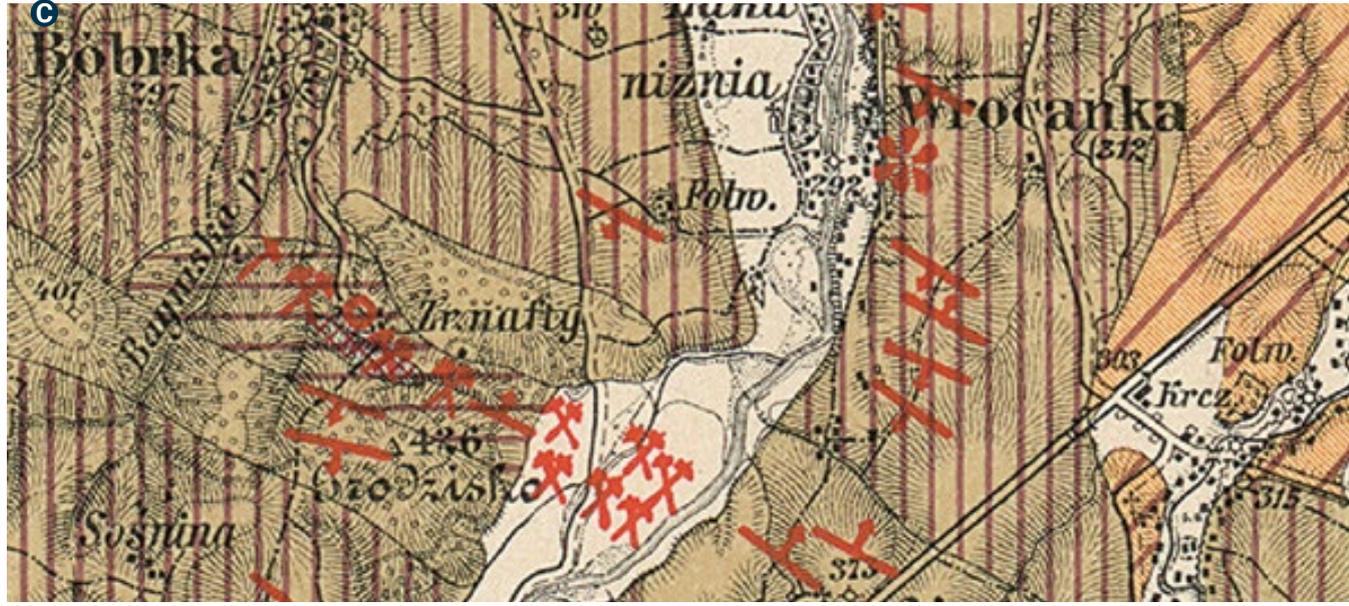
to Vienna in the final years of his studies, Łukasiewicz graduated in 1852 from the university there. Quite possibly in Vienna – then the grandiose capital of one of the world's largest empires – he was acquainted with the latest information on the practical use of oil and the growing interest in oil deposits.

Łukasiewicz the Oil Pioneer

Upon his return to Lwów, apart from continuing his duties at the “Under the Golden Star” pharmacy, he embarked on another path of his career that focused on practical applications of petroleum. In parallel with Abraham Gesner, who developed a process to refine a liquid fuel – kerosene – from coal, bitumen and oil shale, Łukasiewicz, together with his co-worker and business partner Jan Zeh, developed an effective distillation process of kerosene from crude oil. Then, together with Adam Bratkowski, a local tinsmith from Lwów, he designed an effective and safe kerosene lamp. On July 31, 1853, their lamp was first used in a local hospital in Lwów to illuminate

Continued on next page ►





A. Map of oil-bearing areas in Galicia” published by R. Zuber in 1897. Blue: oil fields associated with Cretaceous reservoirs, red: oil fields associated with Eocene reservoirs, violet: oil fields associated with Oligocene reservoirs, green: oil fields associated with Miocene reservoirs. Inset marked in yellow shows location of Bóbrka and associated oil fields, where I. Łukasiewicz established his first oil mine. **B.** Geological Atlas of Galicia, Grybów-Gorlice sheet by Szajnocha (1896a) - part showing vicinity of Gorlice – Libusza, where Łukasiewicz conducted his first activities. **C.** Geological Atlas of Galicia, Jasło-Dukla sheet by Szajnocha (1896b) - part showing location of the Bóbrka oil field.

◀ Continued from previous page

an emergency surgical operation.

In 1854 Łukasiewicz moved to Gorlice in southern Poland, located in a part of the Carpathians well-known for its oil seeps. That year also, together with his business partners Tytus Trzeciecki and Karol Klobassa, he established an oil mine in Bóbrka near Gorlice. This mine first deployed hand-dug oil wells, then wells drilled using manually operated percussion-type drill bit on rods and a free-fall drilling apparatus, and finally cable-tool drilling, powered by a steam engine since

1872. All those technical achievements place the Bóbrka oil mine, the brainchild of Ignacy Łukasiewicz and a result of his perseverance and hard work, amongst the first modern producing oil fields in the world. It can be still admired by enthusiasts of oil industry history at the Bóbrka Museum of Oil and Gas Industry – a true “must-see” for any petroleum geologist.

The establishment of the commercially successful Bóbrka field marks the beginning of the pioneering phase of the development of the modern oil industry in the Northern Carpathians. Later, numerous other oil

fields were put on production in the western Carpathian oil district, such as Siary, Sękowa, Męcina Wielka, Kłęczany, etc. Łukasiewicz had business interests in many of those ventures and he was also instrumental in beginning refineries in Ulaszowice, Siary, Kłęczany, Polanka and Chorkówka – all located in the northern Carpathians.

The second phase of development of the modern oil industry in the Northern Carpathians is associated with the development of oil fields in Borysław region, currently in western Ukraine. This rapid oil industry development, triggered

by Łukasiewicz’s pioneering activities, also included production of natural gas and ozokerite.

Very soon it was realized in Poland that effective oil and gas prospecting required not only luck and business persistence but also professional service: geological, drilling and others. The search for hydrocarbons in the northern Carpathians led, for example, to the development of modern micropaleontology some 20 years before it was used in the U.S. Gulf Coast region. Also, an extensive mapping

See Professional Service, page 25 ▶



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Geophysical Corner

Relative Rock Properties

An alternative to estimate reservoir properties from seismic data

Estimates of reservoir properties (porosity, lithology and fluids) using seismic data are customarily obtained through seismic inversion in two stages: in the first stage rock properties (P- and S-impedances and density, for example) are computed through elastic inversion and in the second stage the estimated rock properties are inverted to the reservoir properties of interest.

Elastic inversion computes rock properties by minimizing the difference between observed data and data modeled through relationships that incorporate AVO, the offset-varying wavelet and a low frequency model (LFM). Under this scheme inversion software searches for the rock properties that result in the synthetic data that best matches the real data. It is a mathematically complex process. The parameters in available software usually are not intuitive and the sensitivity of inverted properties to changes in input parameters is typically poorly understood by the regular user. Parameterization is done, many times, by iteratively modifying parameters and comparing the inverted properties to their equivalent from well-logs.

The LFM, required when inverting to absolute rock properties, provides the low frequency component (including DC) on which the relative changes from seismic are superimposed. Its frequency bandwidth falls outside that of the seismic and it remains mostly unchanged during the inversion process. The LFM is created from non-reflectivity data, usually well-logs and seismic velocities, and its magnitude is several times larger than that of the relative rock properties' changes measured by seismic. A small percent inaccuracy in the LFM can result in errors as large as the range of variation of the relative changes.

Many approaches exist to estimate reservoir properties from the inverted rock properties. Some are qualitative and based on defining in cross-plots (or multi-variate space) the clusters of seismic attributes associated to a reservoir property as determined from equivalent properties from well-logs. Model based approaches are deterministic and relate a reservoir property (i.e. porosity) to a rock property (i.e. impedance) using effective media relationships. Sometimes empirical relationships are obtained by fitting the inverted properties to well-log or core measurements of the sought for reservoir property at well locations. The obtained relationship is then applied to the rock properties in the 3D volume to obtain estimates of the desired reservoir property.

The previous methodology is analyst intensive and the reliability of results is strongly dependent upon analysts' experience. The analyses to compute rock properties and the estimation of reservoir properties are often done by different geoscientists, thus adding uncertainty to the estimated reservoir properties.

Reducing User Input

A methodology is proposed in which relative rock properties are used to compute reservoir (or resource) properties. It reduces user input and simplifies parameterization. In the proposed methodology, each of the components of elastic inversion is done separately and their order of execution is modified. Under this scheme the seismic wavelet is offset-equalized and phase corrected

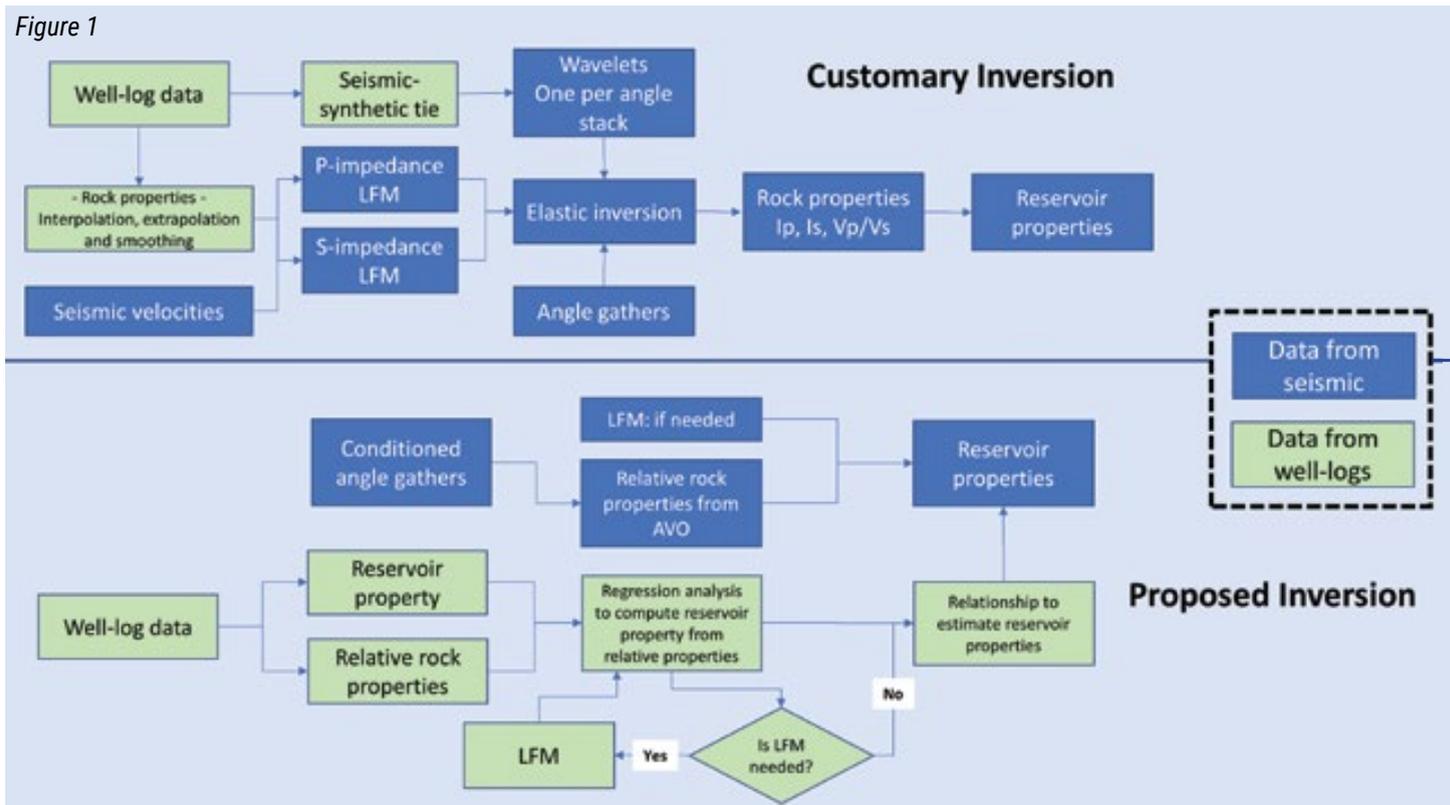


Figure 2

Reservoir properties - computation

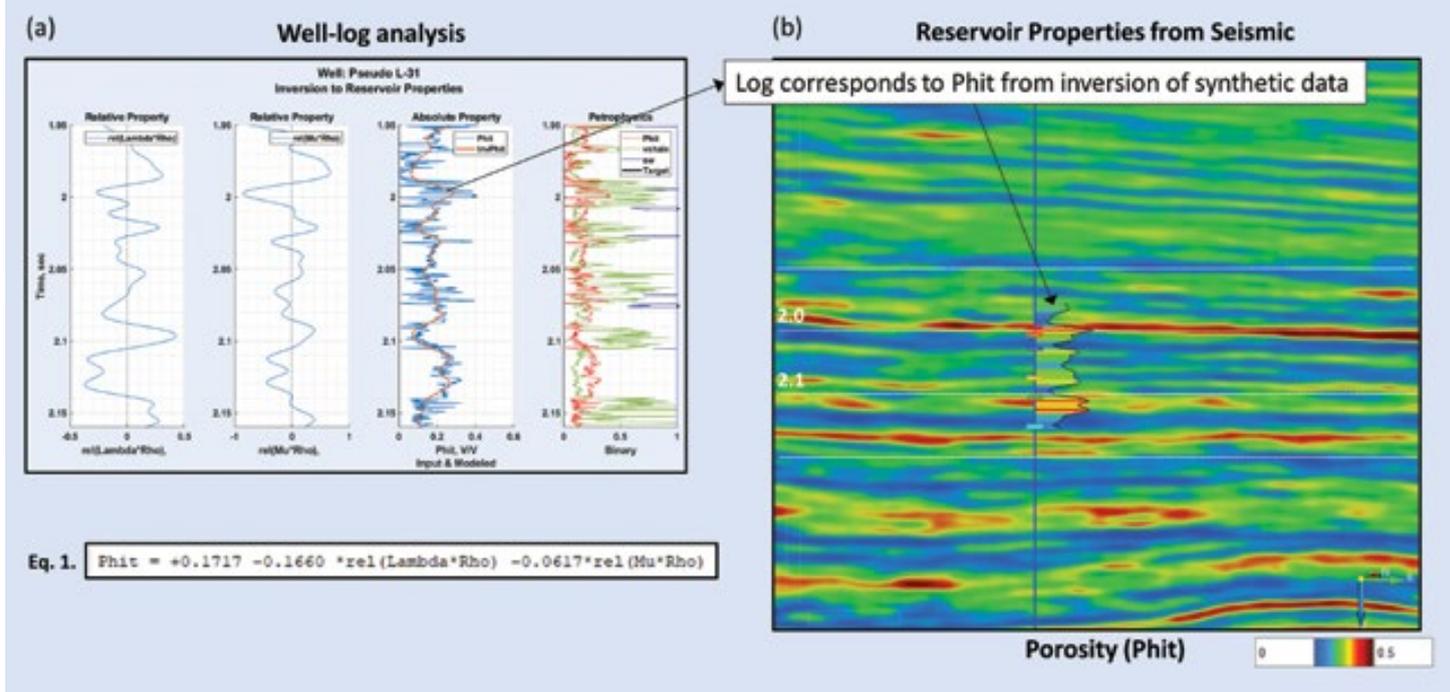


Figure 2: (a) Well-log analysis. Quality control display for the estimation of reservoir properties. The first two tracks are Lambda*Rho and Mu*Rho at seismic resolution. Track 3 shows the total porosity log (blue) and the band-limited porosity (red line) computed using equation 1. Track 4 shows the petrophysical evaluation. (b) Reservoir properties from seismic. In this figure total porosity is computed using the equation obtained from well-log analysis (equation 1). Relative Lambda*Rho and relative Mu*Rho are obtained from seismic by integrating (running sum) Lambda*Rho reflectivity and Mu*Rho reflectivity which are obtained by analytical transformations of AVO attributes.

in the data conditioning stage, prior to computing relative properties. The LFM is incorporated, if necessary, when computing the reservoir properties from relative rock properties. The methodology relaxes the need of a rigorous LFM and bypasses the estimation of absolute rock properties. Figure 1 compares the customary and proposed inversion flowcharts.

Reservoir properties are computed as a linear combination of relative rock

properties. The parameters of the linear equation are obtained from well-log data by least-squares fitting the reservoir property of interest through two or more relative rock properties (regression analysis). The LFM, when required, is input into the regression analysis as one of the properties through which the reservoir property is fitted. The LFM can be the low frequency expression of any property that mimics that of the reservoir property of interest. In

many cases, for example, p-wave velocity from seismic is used as the LFM when computing total porosity. Figure 2a shows a quality control display for the estimation of the linear relationship. In this case, relative Lambda*Rho and relative Mu*Rho, computed at seismic resolution, are linearly combined to obtain a band-limited estimate of porosity.

See **Porosity**, page 25 ►



Alvaro Chaveste holds a bachelor's in geophysics from Montana Tech and has done graduate studies at the University of Houston. In 1983, upon graduation from Montana Tech, he joined GSI in Mexico where he acted as field geophysicist, data processor and administered a pioneering seismic interpretation system (SIDIS). In 1989, when GSI and Geosource merged, he was transferred to Houston where

he has worked for Halliburton, Western-Geco, Core Laboratories, Paradigm Geophysical, Geokinetics and Hess Corporation in managerial positions or as a contributor. His interests include rock physics, seismic data processing, AVO/AVA and inversion. Currently he is the president at TraceSeis where he provides services and develops rock physics and inversion software.



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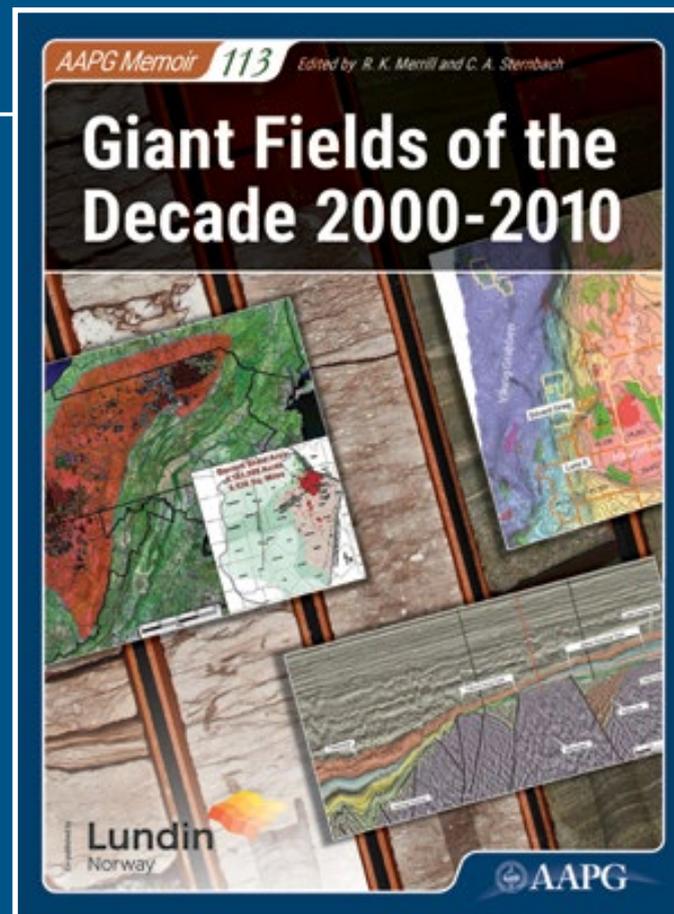
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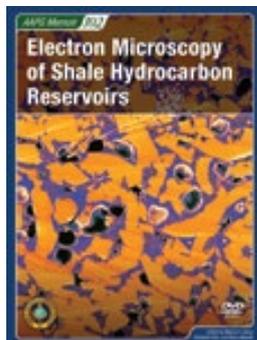
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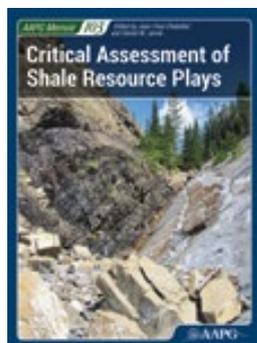
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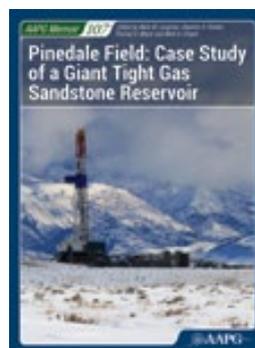
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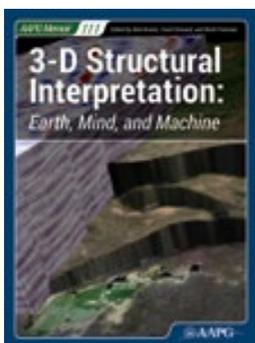
Memoir 107: Pinedale Field: Case Study of a Giant Tight Gas Sandstone Reservoir

Edited by Mark W. Longman, Stephen R. Kneller, Thomas S. Meyer, and Mark A. Chapin

Product #1252

Regular Price: Member \$144 / List \$289

15 chapters that describe the history of field development, deposition and diagenesis, geophysical characteristics, the types and abundance of natural fractures, and fluid production characteristics in the field.



Memoir 111: 3-D Structural Interpretation: Earth, Mind, and Machine

Edited by Bob Krantz, Carol Ormand, and Brett Freeman

Product #1280

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Readers' Forum

The cover feature in December's Explorer (*"Petroleum and Populism" on the cover; "Professional Protesters Threaten Energy Infrastructure" inside*) discusses how best to counteract environmental protests against the oil industry. The purely defensive measures proposed are an inadequate reaction. The industry has to look deeper, at the roots of the protests.

There are some protestors who are motivated simply by a general and indiscriminating animosity toward the oil industry.

Does the oil industry want to take the environmental wind out of the sails of these characters?

If so, addressing the rational concerns of serious environmentalists will help.

In this century, the main environmental concern about the oil industry has been the role of fossil fuels in human-induced climate change. How well has the oil industry responded?

Protests concerning fossil fuels have focused on the producers rather than the consumers of fossil fuels. The oil industry may cry foul, but environmentalists question the industry's readiness to take its share of responsibility. They may reasonably claim that over the last couple of decades the oil industry's acceptance of responsibility to help control carbon emissions has been patchy and reluctant to the point of denial in some quarters. Surely, they might say, an industry staffed with so many geologists can understand the warning messages from past changes in climate that we can now read in high-definition in the geological record?

We geologists can no longer use as an excuse for inaction our traditional skepticism about the various predictive models developed by our climatological

colleagues. Geological evidence for concern about human-induced climate-change is largely independent of the case put forward by the climate scientists. That evidence has continued to strengthen since the Geological Society of London issued its ground-breaking summary in 2010.

Recent evidence from studies of 55 Ma rocks in China and Spitsbergen indicate that we are releasing carbon dioxide into the atmosphere at a rate that is an order of magnitude more rapid than the rate at which the carbon trigger was pulled at the time of the Paleocene-Eocene Thermal Maximum. We would be wise to avoid repeating that warming event through our own agency, but we are well on our way to doing so.

We have a warning from the rocks, and we also have a solution to hand in the rocks: store the carbon dioxide in the subsurface.

Here I should declare an interest: since 2013 I have been advising BHP on climate change and carbon capture and storage.

BHP is currently supporting a research project involving the universities of Cambridge, Melbourne and Stanford, on capillary, solution and mineral trapping of carbon dioxide in the subsurface. Success in that research program would transform the debate on CCS.

There is an AAPG connection here. The Cambridge-Melbourne-Stanford research program was given impetus by a series of conferences on CCS organized jointly by AAPG and the Geological Society of London. Those conferences resulted from an agreement reached in 2010 by President John Lorenz of AAPG with the Geological Society, of which I was president from 2010 to 2012.

The oil industry already knows how to pump large volumes of carbon dioxide safely into reservoirs. Let's get on with doing that on a scale that gives a long-term future

for fossil fuels in a low-carbon century. No environmentalist could protest about that. Unless they really were consumed by irrational animosity.

Bryan Lovell
Senior Research Fellow in Earth Sciences,
University of Cambridge, UK

(This letter also in response to the December cover story.)

I usually turn to AAPG publications when I need reliable scientific data. What I do not need is this article that spreads "false and misleading information in alarming tones" regarding environmental activists. I come here for the science, not a propaganda piece for an energy lobbyist. I am not what the author would disrespectfully refer to as a "professional protester," but I am a concerned scientist who is highly offended that the author would refer to protesters as "extremists."

These folks are exercising their right to free speech and should not be labeled extremists. Regarding the condescending remarks about the "irony" of protestors using petroleum products while speaking out against pipelines and fossil fuels – that is an easy and lazy route to take. Yes, everyone in America uses petroleum products. So, the author is suggesting that if we speak out against continued investments in fossil fuels and passionately advocate for development of renewables, then we are all hypocrites if we use plastic and drive cars?

If energy companies and certain government administrations were not dragging their feet on investment and transition to renewable energy, perhaps those

protesters would have had more alternative non-petroleum products to choose from. The fossil fuels stored in Earth's sedimentary rocks will eventually be depleted. Let's move forward today with an urgency toward developing renewable energy. Let's let go of the debilitating greed of global oil and gas move forward with sustainable cleaner energy sources like wind, water, and solar.

Heather Clifford
Pasadena, Calif.

When working on my story (*the October 2017 Historical Highlights column, "Three Women, One Breakthrough"*), about the three female micropaleontologists, I was alerted to information about Józef Grzybowski, an earlier pioneer with the proposal of using micropaleo and foraminifera for oil and gas by Piotr Krzywiec of Warsaw (past vice president-elect candidate). His is a sad tale, in his discovery never having been embraced by industry and almost entirely slipping into oblivion.

While working on his geology degree in 1894 at the Jagiellonian University of Kraków, Poland, Grzybowski published his first monograph of microfauna of the Carpathian sandstones. In 1895-96, his doctoral work included work on the foraminifera of the red clays of Wadowice. In 1897, he studied the borehole muds of the oil fields of Krosno which led to his 1898 publication of correlation techniques he developed using assemblages of foraminifera. He worked with thousands of samples from 40 wells and illustrated the correlations in his cross sections. He linked this technique to the

Continued on next page ►

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Piotr Krzywiec holds a master's in geology and a master's and a doctorate in exploration geophysics. He studied at the Jagiellonian University and the AGH University of Science and Technology, both in Kraków, Poland, and at Imperial College in London. Having spent 16 years at the Polish Geological Institute in Warsaw, in 2012 he joined the Institute of Geological Sciences of the Polish Academy of Sciences in Warsaw, where he holds the position of associate professor. He has also been an external lecturer in geophysics/seismic

methods at the Jagiellonian University, Kraków, and at the Adam Mickiewicz University in Poznań. His main research interests include integrated analysis of geophysical and geologic data, application of geophysical methods in exploration for conventional and unconventional hydrocarbons, and the history of geology. He has authored or co-authored more than 300 conference abstracts, papers or book chapters published in Poland and abroad. He is an AAPG Member, a member of the Polish Geological Society, Society of Exploration Geophysicists, the Petroleum History Institute, the International Commission on the History of Geological Sciences, of the History of Earth Sciences Society, and the History of Geology Group of the Geological Society of London.

Professional Service from page 21

program was established in a form of the Geological Atlas of Galicia, consisting of 99 high quality geological maps at a scale 1:75 000, published between 1875 and 1912 and covering almost the entire northern Carpathians and their foreland.

Łukasiewicz certainly had a far-reaching vision regarding development of the oil industry that, in his opinion, might have fueled economic development of Galicia, then one of the poorest provinces of the Austrian Empire. Apart from his own successful business ventures, he was instrumental in organizing other professional activities as he clearly saw a need for the exchange of ideas and opinions among professionals involved in exploration and production of oil, gas and ozokerite. In 1877 – i.e. 30 years before the AAPG was established – Łukasiewicz coorganized the first Oil Industry Congress, during which the decision was made to establish the National Oil Society ("Krajowe Towarzystwo Naftowe"), one of the world's first oil industry professional societies. The society ceased to exist in September 1939, at the onset of World War II.

Łukasiewicz the Philanthropist and Statesman

Despite being very busy with his professional life, Łukasiewicz never abandoned his patriotic activities. After the January Uprising in 1863 he supported participants and victims of this and other attempts to set Poland free from its occupants. His charity work was also significant and important, with numerous local establishments such as public gardens, schools, hospitals, local roads, etc., being co-funded from his own resources. In 1873, in recognition of his numerous charitable activities, Pope Pius IX awarded him the title of Papal Chamberlain and the order of St. Gregory the Great.

Ignacy Łukasiewicz died, a rich man, on Jan. 7, 1882. He was buried in Zręcin, a small village located not far from Chorkówka, where one of his best-known refineries was located. He remains well known in Poland and many schools and streets in cities and villages, especially in the Carpathian region, bear his name. He also deserves to be remembered by the world's oil industry as one of its pioneers and founders. [E](#)

Continued from previous page

direct application of the oil industry fieldwork, saying it was better than using (lithologic) logs. He also mentioned that he had not been able to distinguish the K-T boundary with this technique.

While one prominent petroleum geologist, Henryk Walter, Polish counsellor for Mining Affairs, immediately embraced the utility of Grzybowski's techniques, another petroleum geologist, Rudolf Zuber, who was the leading Polish petroleum geologist at the time and author of "Oil and Flysch," was perhaps threatened by this young upstart and chose to ridicule his work, calling it "pointless" and essentially only "fooling around with foraminifera." Though Grzybowski defended his ideas and discovery very succinctly, Zuber's discouraging words took hold. Even in 1970 when Peter Webb, a New Zealand micropaleontologist, was writing about Grzybowski, he noted that Zuber's remarks still tainted the reputation of Grzybowski's foraminifera work.

Meanwhile, Grzybowski went on to other prolific research and work as a scientist and publisher in a great number of aspects of geology from tectonics and geologic mapping of Galicia to writing a drilling manual; but never again did he attempt to publish about and encourage the use of foraminifera for correlations.

Later, he had students who became excellent paleontologists, mostly with

larger forams like nummulites, but his "discovery" was lost to the world of applied micropaleontology. Grzybowski died in 1922 just before the work of the three women in Houston was published in 1923 (the initial breakthrough was presented orally in 1920, more fully in 1922).

The independent discovery of the value of foraminiferal assemblages for correlations and as a substantial contribution to the economics of oil and gas exploration by Alva Ellisor, Esther Applin and Hedwig Kniker in Houston met with a different fate. The utility was immediately recognized and embraced by some of the most respected oil and gas geologists of the time and quickly revolutionized the industry. The women had their antagonist – their own "Zuber" – in the personage of Jessie Galloway, but he was quickly converted to a believer and was soon consulting for oil companies using their technology. It was not until almost 20 years later that their discovery was minimized and credit diverted to their male colleagues.

Even after industry embraced foraminiferal biostratigraphy, Polish geologists did not begin to appreciate Grzybowski's groundbreaking work until 1943 when Heinrich Hilterman of Hannover, Germany, confirmed the utility of his work. Not until 1967 did work begin cataloguing and appreciating the abundant collections of Grzybowski.

Robbie Gries
Denver, Colo.

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This seminar conforms to the Department of the Treasury OFAC update of 11/10/2017, 31 CFR part 515.565 (b) 1-6, p.23; <https://federalregister.gov/d/2017-24447>

Foundation Update

Unexpected Gift Honors Geologist's Legacy

Recently the AAPG Foundation received a generous bequest gift – in excess of \$600,000 – from longtime member Frank Adler. It was completely unexpected.

In reviewing his file we noted only that Adler was an AAPG Emeritus Member and an occasional donor to the AAPG Foundation, but nothing in his record suggested his intentions. And we wondered: Who was Frank Adler and what prompted him to leave such a generous gift to the Foundation?

His daughter Annette shared his story through a short obituary that began: Frank Adler of Littleton, Colo., passed away on Friday, Feb. 3, 2017 – two days after celebrating his 96th birthday.

He grew up in the New York City area and dreamed of exploring the west. As a youth he prepared himself for this adventure by joining the Boy Scouts and hitchhiking throughout the state.

His dream became reality when he moved to Golden, Colo., to attend the Colorado School of Mines. This community located in the foothills of the Rocky Mountains captured his heart and launched a career that would last a lifetime.

Adler's Career

After graduating in 1945 with an engineering degree and a brief job with another firm, Adler accepted a position with Phillips Petroleum, where he remained throughout his professional career.

As a young professional Adler saw the value in joining a professional association and so became a member of AAPG in 1945. The Association was a way to network with fellow geoscientists, a reliable

way to share the science through collaboration and publications, and a way to preserve the science and history through maps.

His activities with AAPG began with volunteer service in 1960 as a member of the Publications Committee. He went on to serve 14 years as an associate editor (1971-85), a member of the Stratigraphic Correlations Committee (1976-82) and as a delegate for the House of Delegates (1977-78).

A career highlight was being asked to serve as Phillips' representative for the AAPG's "Big Red Book" – the RMGA's Geologic Atlas of the Rocky Mountain Region. Published in 1972, this book was an instant classic with its extensive paleo geographic maps.

The book, which had an editorial staff of 26 and authors from 43 separate companies and institutions, took six years to complete and remains to this day a valuable digital publication resource. Adler was reportedly proud to have been part of this project.

He also proudly contributed to many critically important stratigraphic surveys of North American natural resources, including (1976-82) the Correlation of Stratigraphic Units of North American (CONSUNA).

A Love of Rocks, Among Other Passions

While at the Mines he met Martha White, who was working in the president's office. They were married and celebrated 49 years together. During this time he continued his exploration of the west, with focus on his beloved Four Corners area.

Before and after his retirement, Adler stayed active

Continued on next page ►



Frank Adler

Who are the Trustee Associates?

Rock-solid AAPG members who want to give back to the science and profession that has given them so much.



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- Lending guidance and support to its fundraising efforts.
- Guiding the scientific and educational agenda, which it underwrites.

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◀ Continued from previous page

and engaged with the Denver community as a fencing instructor for the Mile High Fencing Club in Lakewood, a volunteer guide for Dinosaur Ridge in Morrison, and as a member of the Denver Mining Club and the Colorado School of Mines Alumni Association.

"Dad loved rocks above all else," his daughter Annette said. "He had walked much of the West at one time or another and knew it very well. He loved to tell stories about his adventures in the mountains to his two grandsons, Rob and Sam."

After 72 years as an AAPG member Adler's final act was to leave the unexpected bequest gift to AAPG Foundation – a donation that will serve as a lasting legacy from a man who loved rocks and wanted to give back to the profession that had given him so much.

For that the AAPG Foundation is truly grateful and will use this gift to fulfill the mission and purpose for which it was established.

* * *

We also recently reached an exciting milestone for the Deana and Paul Strunk Military Veterans Program: Thanks to the generosity of AAPG members, the Foundation hit \$1 million dollars in the MVSP endowment.

This will enable the Foundation to award scholarships to even more U.S. military veterans, providing assistance to ease their financial burdens of returning to school.

To all who donated to the fund, thank you. And to those who feel drawn to this initiative, please help us to keep growing this fund. Your gifts will continue to be important and much appreciated.

* * *

Considering leaving a legacy gift through your estate to AAPG Foundation?

Visit foundation.aapg.org/donate/legacy_society.cfm for details. 

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

Foundation Contributions for November 2017

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Mohammad Abdullah
 Sophia & G. W. Brock
 John Richard Carson
 Brenton Michael Chentnik
 Norbert F. Csaszar
 Graham Rhys Davies, PhD
 ExxonMobil Foundation
 Robert E. Fox
 John D. Humphrey
 Elizabeth Johnson
 Jim & Carolyn McGhay
In honor of AAPG's amazing staff
 Richard Fastabend Meyer
In memory of Thomas Fitzgerald
 Leslie Owen Niemi
 Elia Pliego-Vidal
 Kenton Nile Riggs
 Dayna Jean Salter
 Robert W. Sullivan
 April R. Wisebaker

Amoruso Special Publications Fund

Phillip & Sarah Forney
In memory of Elwin Peacock
 Anthony Reso

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Bernold M. "Bruno" Hanson Memorial Environmental Grant
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J. Ben Carsey, Sr. Memorial Grant
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 ExxonMobil Foundation
Robert K. Goldhammer Memorial Grant
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Suzanne Takken Memorial Grant
 Elizabeth Johnson
Wallace E. Pratt Memorial Grant
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Gift of Exxon stock

Imperial Barrel Award Fund

Richard Leroy Adams
Grant from Adams Family Donor Advised Fund at East Texas Communities Foundation
 Kevin T. Biddle
In honor of Miguel Uliana
 Chevron
 Elia Pliego-Vidal

Military Veterans Scholarship Fund

Norbert Everett Cygan
In honor of Sotex Vets
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In memory of Pete Gray
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In memory of Roy W. Foster
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Newly Released Publications Fund

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Visiting Geoscientist Fund

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L. Austin Weeks Undergraduate Grant Fund

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Matching gift from Wayne A. Schild



Mark Your Calendar!

Important Award Deadlines 2017-18

L. Austin Weeks Undergraduate Grant Program OPENS: DEC. 15, 2017 | DEADLINE: FEB. 15, 2018

The L. Austin Weeks Undergraduate Grant program provides \$500 grants to undergraduate students and geoscience student associations (student chapters and clubs) worldwide to help with tuition, books, field trips and conferences.

Inspirational Geoscience Educator Award OPENS: JAN. 15, 2018 | DEADLINE: MARCH 1, 2018

The Foundation will award \$6,000 to a college or university professor for Excellence in the Teaching of Natural Resources in the Earth Sciences. **Nominate a professor who impacted your career in geology today.**

Deana and Paul Strunk Military Veterans Scholarship Program

OPENS: FEB. 15, 2018 | DEADLINE: MAY 1, 2018

The Military Veterans Scholarship Program (MVSP) is designed to support veterans pursuing geoscience education programs at a four-year college or university. Grants range from \$2,000 to \$4,000 each and are intended to provide financial assistance to veterans who are studying undergraduate level geoscience.

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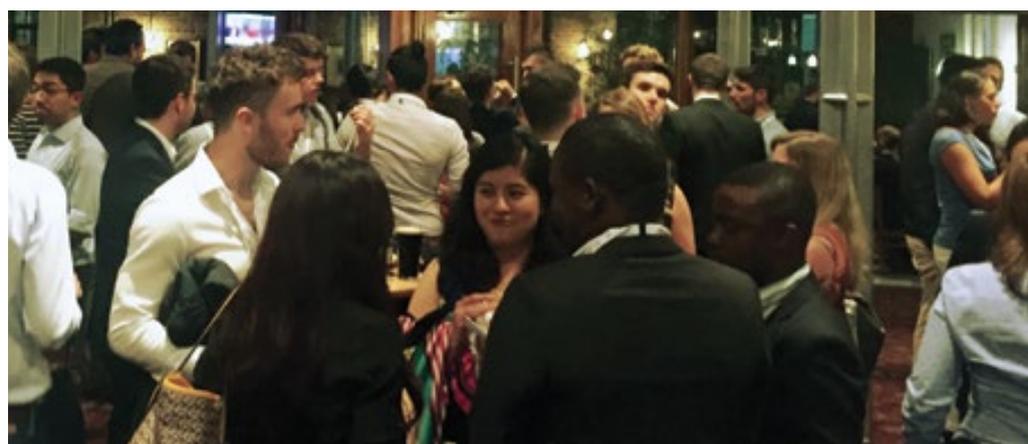
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Wesley Weisburg, 2015 MVSP recipient

Pro Tracks

The YP and Student Experience at ICE



Left: Prize draw for the Student and Young Professional Networking Challenge.
Right: Student and Young Professional Reception in the FOX pub at ExCel

The Europe Region Young Professionals had the privilege of hosting several YP events during the recent 2017 AAPG International Conference and Exhibition in London. The theme of ICE, "100 Years of Science Fuelling 100 Years of Prosperity," was particularly appealing to YPs as many are beginning to see positive industry trends after having endured a tough few years.

The London AAPG YP Chapter has been active since 2011, organising a range of events like networking evenings, career talks, sport events and the famous yearly Christmas quiz. Many of these events are in collaboration with the London Petroleum Exploration Society of Great Britain YPs. And, 2017 marked a special year for the

London YPs, as it was the first time we experienced an AAPG technical meeting in our backyard. For many of us, the first opportunity to attend an international AAPG event was even more special because it coincided with the AAPG centennial celebration. London YPs helped to organize the London ICE Student and Young Professionals program, and the hard work paid off as London ICE 2017 was an absolute success.

The conference kicked off with the Student and YP Meet-n-Greet. This initiative was to bridge the gap between students, YPs and experienced professionals. The event commenced with an introduction from London YP President Myriam Cuylaerts and Jon Peachy of Shell. The

London ICE Meet-n-Greet also served as the launch of the "Student and YP Networking Challenge," a competition that provided a platform for enhanced networking by requiring participants to collect signatures from AAPG officers and members within the industry, exhibitors and conference speakers.

Day two of AAPG ICE was another busy one for YPs. Several were engaged in chairing oral sessions as well as judging posters. On the exhibition floor, YP and student poster presentations garnered a lot of foot traffic. That evening, the student and YP reception took place at FOX bar at ExCel, and was graciously sponsored by ExxonMobil, and we thank them for their continued sponsorship of AAPG YP

programs.

Finally, during day three of ICE, the results from the Student and YP Networking Challenge were revealed. A few contestants managed to gather all required signatures, and the overall winner was Anouk Beniest from IFP Paris. Anouk left ICE with a new ammonite that will help to decorate her desk.

World-class events like AAPG ICE provide younger AAPG members with exposure to innovative technologies and networking opportunities that are necessary to overcome some of challenges that we currently face. Thank you to all that participated in YP activities at ICE. We had a wonderful time and look forward to building on this experience. 



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Geosciences Technology
Workshops 2018

Pore Pressure and Geomechanics: From Exploration to Abandonment

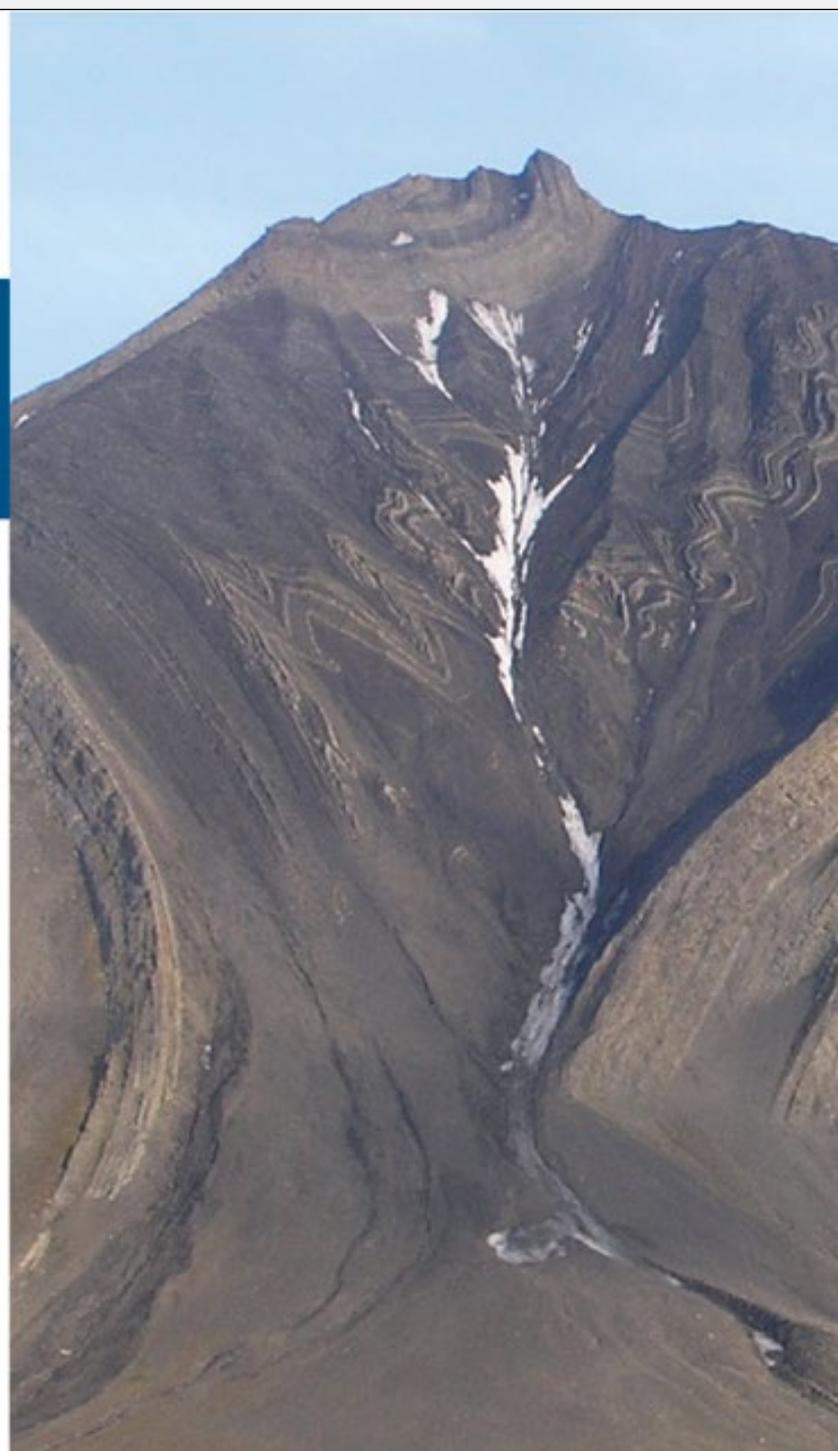
Perth, Australia • 6-7 June 2018

Geomechanics and pore pressure provide valuable insights and applications in acreage selection and prospect risking, well planning and field development planning, as well as completions, reservoir modeling, enhanced recovery, and eventual field abandonment. Furthermore, geomechanics in particular has been an essential aspect of unconventional hydrocarbon production, providing critical inputs for fracture stimulation, directional drilling and field planning that have drastically changed the industry.

This two day workshop will bring together a wide range of geoscientists, engineers, and managers to highlight the important and varied roles that geomechanics and pore pressure play from initial exploration phases through to field abandonment. This workshop will also highlight the key aspects and elements that are unusual or unique to geomechanics and pore pressure analysis in Australia and Asia. These basins are often characterized by complicated geology, variable and high-magnitude stress states and anomalous overpressures. Key themes will follow the use of geomechanics and pore pressure throughout the well life-cycle.

For more information, contact apereira@aapg.org

aapg.to/PorePressure





Porosity
from page 22

The last step in the proposed methodology is to compute reservoir properties in the seismic volume using the linear relationship estimated from well-log data. Relative properties from seismic are obtained by integrating (running sum) the reflectivities of the corresponding rock properties obtained through analytical transforms of AVO attributes. In the

example shown (figure 2b), porosity is computed from seismic through the linear combination of relative $\lambda \cdot \rho$ and relative $\mu \cdot \rho$ obtained in the well-log analysis shown in figure 2a.

The proposed methodology computes, from seismic data, quantitative estimates of any reservoir (or resource) property that can be represented as a linear combination of relative rock properties. Effective porosity, brittleness and mineralogy (including volume fraction of kerogen) are examples of properties to which seismic data can be inverted. [E](#)

In Memory

- William Corea, 65**
San Ramon, Calif., Sept. 11, 2017
- John Dyni, 85**
Lafayette, Colo., Sept. 24, 2017
- James Farley**
Conroe, Texas, Nov. 9, 2017
- Weldon Frost, 86**
Longboat Key, Fla., July 2, 2017
- Jimmy Gowens, 69**
Lenexa, Kan., April 8, 2017
- Jason Henthorne, 47**
Wooster, Ohio, Sept. 8, 2017
- Arthur Johnson, 65**
Kenner, La., Aug. 9, 2017
- Ludano Lucarelli, 86**
Hollywood, Md., Jan. 17, 2017
- John Melton, 86**
Santa Fe, N.M., March 31, 2017
- Hugues Monrose, 81**
Othis, France, Oct. 20, 2017
- Franz Nieberding, 67**
Lingen, Germany, Oct. 8, 2015

- Gary Reid, 62**
Broken Arrow, Okla., Aug. 29, 2017
- George Rogers, 85**
Dallas, Texas, Feb. 28, 2017
- Kenneth Sharp, 89**
Port Charlotte, Fla., Oct. 24, 2017
- Howard Shaw, 92**
Santa Maria, Calif., Nov. 20, 2016
- Robert Spiller, 67**
Round Rock, Texas, Dec. 30, 2016
- Michael Welland, 71**
London, England, UK, Oct. 12, 2017
- David Wiltshcko, 63**
College Station, Texas, March 2, 2012
- George Witter, 84**
Bakersfield, Calif., Aug. 14, 2017

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

DPA
from page 30

makers Forum, "Re-emerging" Shale Plays of the Gulf Coast" in Houston in April of 2018. This will be an exciting conference with the re-emergence of the Haynesville as the 800-pound shale-gas gorilla. This conference brings with it new technologies and new lessons that also apply to other plays. We hope to include the Austin Chalk and Cotton Valley as they also fit the themes of "re-emergence," although they

are not classic shale plays. These forums have contributed greatly to the AAPG during these challenging economic times and we continue to explore methods to better monetize our unique knowledge to the benefit of the members.

I have always tried to hold to the idea that surviving hard economic times is strongly related to attitude. Opportunities abound in these times if we can see clearly with a focus on the future. With that, I wish everyone a wonderful Holiday Season and a very prosperous New Year! [E](#)



Innovations Bring Once-Dying Shale Plays Back to Life

Haynesville and Re-Emerging Resource Plays of the Gulf Coast

DPA Playmaker Forum
26 April 2018
Marathon Oil Conference Facility
Houston, Texas

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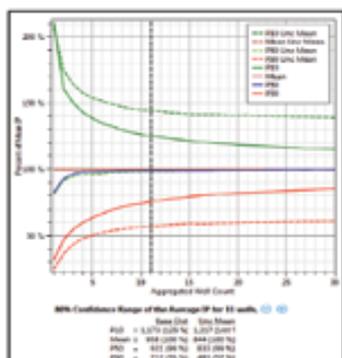
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Director's Corner

Saying Goodbye to a Champion of AAPG

In the middle of December we received sad news at headquarters: AAPG Honorary Member and leader R. Randy Ray had passed away after a quiet 15-month battle with cancer. He was 66 years old.

The news came as a shock as Randy, a private person, did not wish to publicize his illness. But as his wife Kathy wrote in a note to Alan Wegener, AAPG's managing director for global business, it was his AAPG friendships and committee service that kept him going during the clinical trials and treatments that he undertook.

Feelings of loss are not uncommon when we lose a friend or colleague, and that has proven particularly true in this case. As Alan observed to me, Randy was a champion of both AAPG and its staff.

He was a tireless volunteer, working from his base in Lakewood, Colo., contributing both to his local societies – the Rocky Mountain Association of Geologists and the Denver Geophysical Society – and international societies, like AAPG and the Society of Exploration Geophysicists (SEG).

His Impact on AAPG

Vision energized by optimism and enthusiasm fueled his activities. As both a geologist and geophysicist, Randy sought to build bridges between the disciplines.

He was a longstanding member of both the AAPG Geophysical Integration Committee and the AAPG-SEG Cooperation Committee. He was one of the originators of the Denver Geophysical Society's 3-D Seismic Symposium, which is planning its 24th installment in March of this year.

For six years Randy served as chair of the AAPG Global Events Oversight Committee, continuing as a committee member until the day he died. He loved conferences.

In 2009 he was the general chair of AAPG's Annual Convention and Exhibition in



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“It was affection that . . . drew Randy to AAPG, SEG, RMAG and DGS – he liked people and they genuinely liked him. These relationships were a great source of both professional and personal satisfaction.”

Denver. When AAPG joined with SEG and the Society of Petroleum Engineers to launch the Unconventional Resources Technology Conference in 2013, Randy served as an enthusiastic member of the technical program committee. The following year he served as SEG co-chair for URTEC.

As AAPG President Charles Sternbach eulogized, “Randy is organizing a conference in heaven, it will be multidisciplinary, and the house there will be packed, too!”

When SEG approached AAPG in 2012 about launching a new interdisciplinary journal – Interpretation – focused on subsurface exploration, Randy stepped forward to serve as AAPG's appointed deputy editor-in-chief. He was committed to the topic, to cooperation between AAPG and SEG and to the journal's success.

A Possibility for Joy

I got to know Randy best during his term as chair of the House of Delegates serving on the Executive Committee in 2013. This is a leadership position that requires an ability to balance many diverse interests and opinions. A good listener, Randy solicited and absorbed perspectives from many individuals and processed that input through a primary filter: what is best for AAPG and its members?

He actively used his AAPG experience to broaden his own knowledge and

perspectives. Attending the AAPG International Conference and Exhibition in Singapore was his first trip outside the United States. He followed it with several visits to APPEX, AAPG's prospect and property expo in London, accompanied by his younger son.

And while his friends feel a sense of loss, it is his family – his wife Kathy and his sons Austin and Brandon – who were closest to him and bear the heavy burden of sadness and grief during these moments.

But even in mourning there is a possibility for joy.

“Affection is responsible for nine-tenths of whatever solid and durable happiness there is in our natural lives,” observed author C.S. Lewis in “The Four Loves.”

Anyone who witnessed Randy and Kathy together has evidence of this fact.

It was affection that also drew Randy to AAPG, SEG, RMAG and DGS – he liked people and they genuinely liked him. These relationships were a great source of both professional and personal satisfaction. In my reflections about Randy over the past several weeks, what strikes me was how intentional he was about his relationships.

Here at AAPG we talk a lot about networking, community and relationships. But how often do we take the time to make that phone call, send a hand-written note or simply listen attentively while

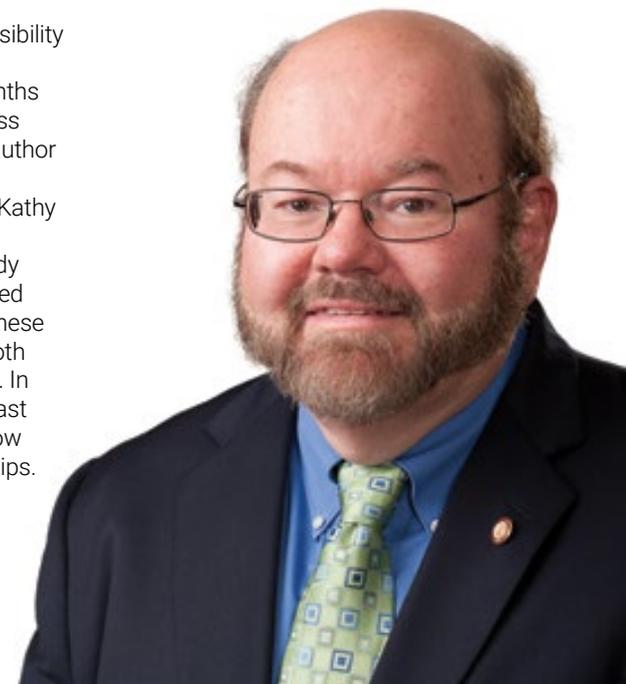
someone else is talking? Randy did all these things.

A personal example: When Randy chaired the HoD, he held his midyear leadership meeting in Boulder, Colo., showcasing the hospitality and charm of that college town.

One year later, as a newly-married man, my wife Susan and I checked into the same hotel for a few days. In our room we found a beautiful, small chocolate cake with a hand-written note, “Congratulations and best wishes on your marriage. Sincerely, Randy and Kathy Ray.”

It's not the size of the gesture that counts. It's the intent. And I'll never forget it.

David H. Hill



By JIM HILL, DPA President

Divisions Report: DPA

DPA Offers New Programs in the New Year

As I have gotten older, it has become obvious to me that time has started to pass much faster.

Maybe it is the speed of technology, the slowing of the Earth's rotation or the number of section meetings I attended this past year, but I can say for certain that time has flown by this year.

This fact has also been confirmed by my youngest granddaughter growing two more inches and going from crawling to running around the family room so fast it is hard to catch her. I have also had to relocate several sparkly mineral samples that she finds fascinating. (Go little Geo-Girl!)

The year has been a busy one.

I was pleased to be able to attend the section meetings in Anchorage, Morgantown and Oklahoma City, as well as the ACE meeting in Houston and the ICE meeting in London. These meetings were amazing, with strong technical content and great networking and social events. I salute the convention committees and officers that put together these meetings. Great Job!

For me, a big benefit of attending these meetings is the ability to meet these committee members and officers and other special people that really make the sections and the AAPG work for the benefit of all our members. The Awards Committee had a



HILL

“The Division members need to advance our knowledge about communications and data management in this new exploration world. New oil is found by new ideas and technologies and we need to know how best to serve our members”

hard time this year as there were so many people deserving of recognition. The staff at AAPG headquarters, despite reduced staffing, has continued to deliver on programs and events in support of the meetings. And I sincerely thank them for continuing to work so hard for the membership.

New Member Category

This year the Division of Professional Affairs has a focus of bringing early career professionals into our division with the new member category of Provisional DPA member. The requirements for certification have not changed but the new category allows an AAPG Member in good standing to join the DPA before the required experience level for certification is reached. When the needed years of experience are reached,

the member must apply for certification or be dropped from membership. Provisional members have all the same benefits as certified members, except it is a non-voting and non-certified level.

Provisional members can serve on committees, and their ideas are much needed. The Division members need to advance our knowledge about communications and data management in this new exploration world. New oil is found by new ideas and technologies and we need to know how best to serve our members. By bringing these Young Professionals into the division, we will incorporate their energy and vision into the future of the DPA. Being a DPA member will also give our YP's a much greater opportunity to network and build relationships with many of our more “seasoned” members.

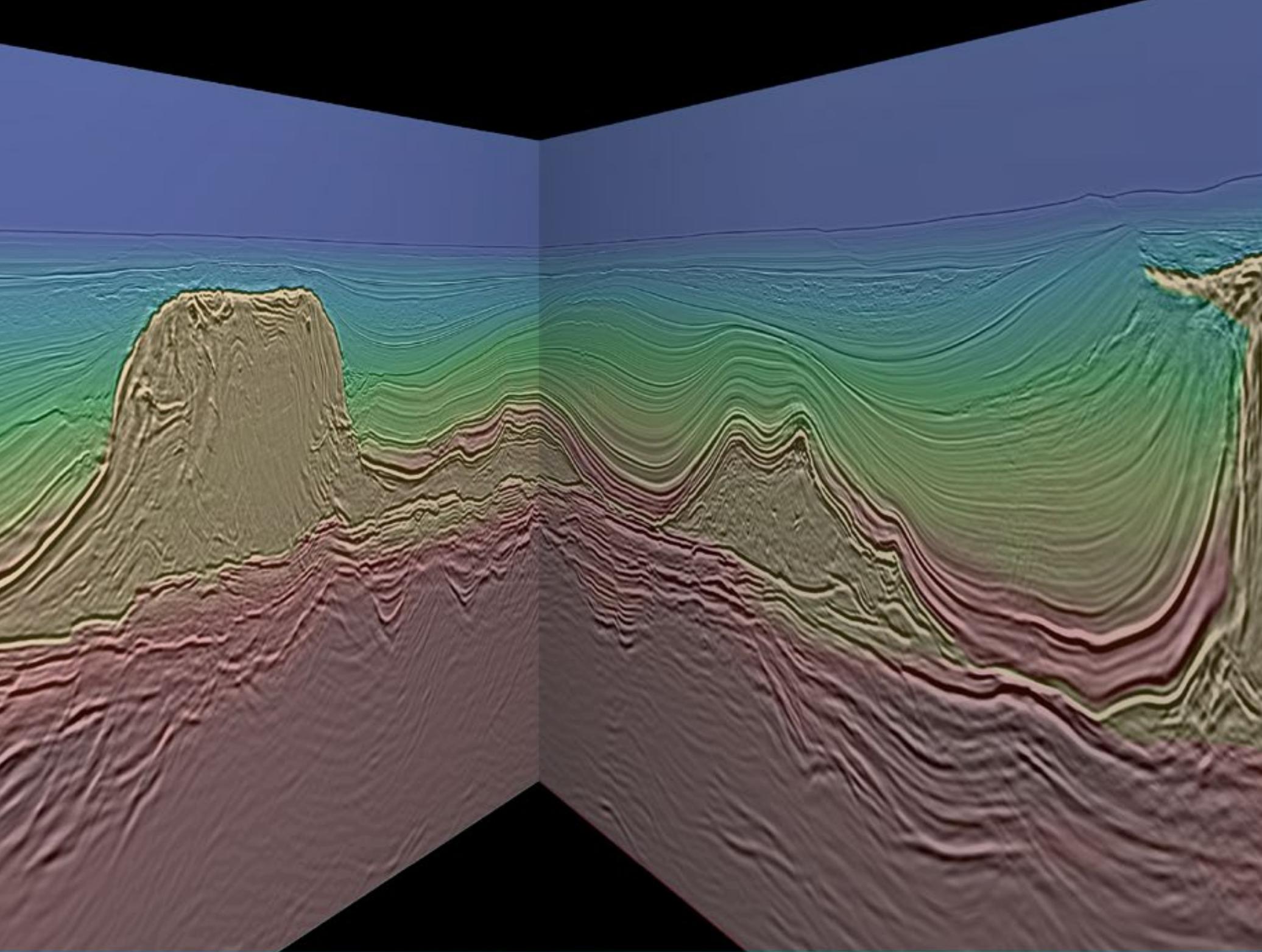
Short Courses in 2018

The DPA has always tried to give our members relevant education and career development courses. Keeping that in mind, we will be bringing back some of short courses on how to interpret old well logs with an added section on how to get the most out of dipmeter data. There is no question that 3-D seismic has revolutionized interpretations, but in complex geologic areas where the data is poor, a dipmeter can be a very powerful tool. I can say that several of the discoveries with which I was involved were directly related to a solid dipmeter interpretation. The industry has spent billions of dollars acquiring data, and even old data can be of great value if we understand its limitations and how to use it. We are working hard to have these courses ready by the ACE meeting in Salt Lake. The ACE meeting this year will be one of the best with strong technical sessions with a focus on value to those that attend. The field trips will be amazing as well.

New Playmakers Forum

The Division is also planning a new Play-

See DPA, page 29 ►



Santos Basin

Brazil – Santos Vision Area 1

PGS announces the availability of Area 1 from its Santos Vision project within the pre-salt play in the Santos Basin, offshore Brazil. The total project will cover 34 000 sq.km. Exploration plays in Area 1 include: a rift/pre-rift fault-trap play in the west-central part of the area, with prospective siliciclastic reservoirs in the Paleozoic pre-rift through Lower Cretaceous rift succession; a sag/rift limestone edge play (Sagitário trend), involving subsalt structural or paleo-topographic traps in microbial platform limestone; and the Carcará North/Uirapuru sag-rift limestone play, which includes the Carcará discovery in BMS-8 and several significant closures at the base of salt.

Santos Vision Area 1 deliverables will be available for the upcoming license rounds.

Please contact: brazilinfo@pgs.com

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