AAPG EXPLORER
NOVEMBER 2016

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Vol. 37, No. 11
November 2016

AAPG EXPLORER

PRESIDENT'S COLUMN

Innovation and the Future of Geoscience

BY PAUL BRITT

In the last two months, I have been to an international conference, our own International Conference and Exhibition (ICE), and the Gulf Coast Section, Eastern Section and Pacific/Rocky Mountain Section meetings. The meetings were mostly lightly attended, but the geologists in attendance were enthusiastic and optimistic about their profession, even if some were apprehensive about their immediate employment futures.

At each of these events, I met with student chapter groups and I was usually accompanied by other AAPG Delegates, Executive Committee members, or AAPG staff. The student chapter leaders and members were enthusiastic and energetic. They were in various stages of undergraduate and graduate programs and many were preparing to graduate soon. Each had questions about their opportunities and their future.

In the present business climate, those aren't easy questions to answer. Stressing their love for geology to carry them forward was the main theme of our discussions. They had questions about what types of fields would be best to pursue, whether to get a master's degree or doctorate, and they always finished with "What's the price of oil going to be?" We could recommend fields and particularly types of companies, such as smaller independents, service companies, or non-petroleum disciplines to which they might not have been exposed in school, since many students think along the lines of major oil companies and national oil companies. In the end though, while we talk about careers, they are just thinking about their first job.

We also met with Members who were Young Professionals. Many were employed, but some were recently unemployed. These were experienced geologists early in their careers who had


BRITT

As with many innovations, there is likely a technology we are not even aware of right now that could have the biggest impact on our science.

many of the same qualities and asked the same questions as the students. The advice was along the lines of learning more of the tools in common use among the smaller companies, such as PC-based workstation software, and expanding their scope of knowledge into petrophysics and other related fields. The PC-based software is in far broader use than the high-end products that are more often limited to larger companies and universities.

But even more importantly, how is future innovation going to affect the geoscience career?

Past innovations in the petroleum geology field are advances like wire line electric logs (the oldest I've used for interpretation was run in 1930 in a well in South Texas), improved drilling techniques that permit deeper drilling and in more hostile drilling environments, offshore drilling, 2-D seismic, 3-D seismic, horizontal drilling and hydraulic fracturing.

Many of these, you might say, are engineering innovations, but they were either driven by geologic exploration pushing the envelope toward new frontiers, or as an iterative process of geology and engineering with a back-and-forth advancement in each of the fields.

The latest example of this innovation are the unconventional plays, which have virtually reversed the production decline in the United States by exploring and developing the source rock itself.

What are some of the potential new innovations that we can see today? The following are but a few possibilities:

Drones

Come on now – if these were available when we were in school or early in our careers, what would we be doing differently today?

Well built, fairly inexpensive flying machines, capable of carrying high-resolution cameras and other remote sensing tools – LiDAR, geochem sampling, surface logging equipment – using GPS (another innovation I didn't mention earlier) for accurate location. What if you could do an airborne gas detection survey over an area and map it? Literally, the sky's the limit.

Mapping an outcrop in detail without having to climb over all of it, surface geological mapping and other uses like environmental mapping and accurate location of geological features in the field – these are just a few applications for drones (see related articles on pages 14 and 26). How much more of the study area could you cover in a fraction of the time, allowing you to focus on the anomalies and points of interest with an on-the-ground follow up?

Not only can fieldwork be done faster, but so much more field work is possible because the cost (in time) is dramatically reduced. Drones are already being used for pipeline inspection and facilities inspection.

What could you do with a drone?

Nanotechnology

"nan·o·tech·nol·o·gy: the branch of technology that deals with dimensions and tolerances of less than 100 nanometers, especially the manipulation of individual atoms and molecules."

It is a young field of study of a world so small we can't see it, even with a light microscope. This is a technology of building machines at a molecular, or even subatomic, level.

In 1981, scientists gained a new tool powerful enough to allow them to see single atoms. This device, the scanning tunneling microscope, uses a tiny electric current and very fine needle to detect the height of individual atoms, and pick up, move, and precisely place atoms, one at a time. Right now, nanotechnology is being studied primarily for materials science, chemistry and medicine.

It is a science in its early stages, but what if it, instead of water and gas floods of reservoirs, could eventually be used for enhanced recovery by using molecular alteration to increase reservoir permeability or change fluid viscosity? What if it could be applied to block water production in a reservoir, or used as a replacement of hydraulic fracturing by changing the rock properties of the formation?

The impact on geoscience would be immense, opening up the field of reservoir revitalization, recovering hydrocarbons left behind in an old field.

Nanotechnology falls in the category of "too soon to tell" right now, but the potential for the future makes it something to watch.

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REGULAR DEPARTMENTS


Courtesy of the Boy Scouts of America

ON THE COVER:

As the downturn drives oil companies to find more efficient, economical and effective methods for gathering data, drones are increasingly becoming the go-to technology, along with other modern innovations not traditionally associated with the oilfield. See pages 14 and 26 for the full stories.

Left: The Boy Scouts of America are calling upon any and all geologists with an interest in teaching young people, enjoying the outdoors and having a great time to volunteer at the upcoming National Scout Jamboree in Beckley, W. Va. See page 30.

Vol. 37, No. 11

The AAPG EXPLORER (ISSN 0195-2986) is published monthly for members by the American Association of Petroleum Geologists, 1444 S. Boulder Ave., P.O. Box 979, Tulsa, Okla. 74101-3604, (918) 584-2555. e-mail address: postmaster@aapg.org. Periodicals Postage Paid at Tulsa, OK and at additional mailing offices. POSTMASTER: Please send address changes to AAPG EXPLORER, P.O. Box 979, Tulsa, Okla. 74101. Canada Publication Agreement Number 40063731 Return undeliverable Canadian address to: Station A, P.O. Box 54 • Windsor, ON N9A 6J5 • E-mail: returnsIL@imex.pb.com

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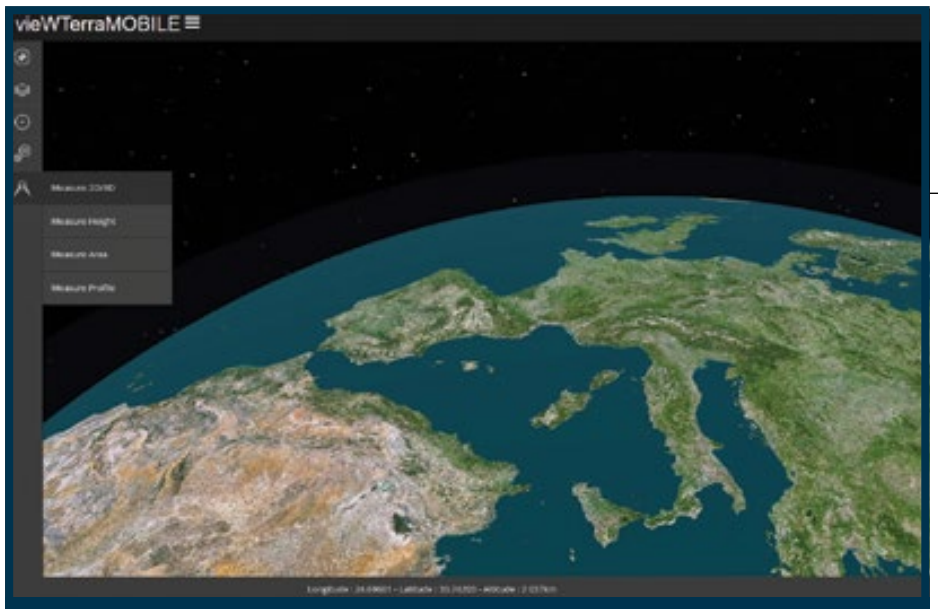


A screen capture of the Digital Immersive Geosciences software in operation.

Immersive Geosciences Platform Developed

AAPG and VWORLD have created the first interactive digital publishing medium to deliver immersive, in-depth training opportunities for geoscientists.

"Currently AAPG offers technical journals in traditional formats. With Digital Immersive Geosciences (DIG) we are launching the first interactive digital publishing medium in the geoscience community," said Jim Blankenship, geoscience director for AAPG.

"Imagine sitting at your desk and being able to see, study and experience rocks, outcrops and geologic formations that are thousands of miles away," he said.

"Partnering with VWORLD has enabled us to take that next step and use the latest technology to develop a true, immersive experience."

A software development company based in France, VWORLD will develop, design, launch and maintain the platform application built on their vieWTerra Evolution 4-D real-time Earth Viewer software. VWORLD specializes in 3-D real-time terrain visualization for simulation, training, situational awareness, navigation aid, command and control, crisis management or landscape planning needs.

"We're thrilled about our partnership with AAPG which gives us a tremendous occasion to showcase our vieWTerra Evolution 4-D Globe Viewer to the worldwide geoscience community at large, and expand our reach to global clients in the oil and gas sector," declared Vincent Pourieux, president and CEO of VWORLD. "The underlying technology behind vieWTerra is procedural, and that will impart the DIG application with an unprecedented degree of immersion and realism in the 3-D landscapes produced."

According to Jerry Jefferis, AAPG project manager for the DIG program, "VWORLD was a logical fit for the partnership based on their GIS and simulation software experience across multiple industries."

"This software is the new standard for future geoscience publishing and field trips," added Blankenship. "A normal field trip involves field descriptions, maps, photos and publications in a 2-D setting. DIG uses existing technology to create a collection of virtual field trips. This allows a researcher, practitioner, teacher or student the opportunity of not only a virtual visit to the field location, but to move around and view the geography and geology in a spatially oriented sense. Similarly, it allows full immersion in journal publications with users able to review and inspect those in a true 3-D spatial environment rather than conventional 'flat' electronic or paper journal manuscripts," Blankenship concluded.

The DIG software is fully customizable and can be loaded with an individual company's outcrop datasets to create a desktop or tablet application resulting in a friendly, interactive, immersive application that is simple to use.

"When it's released next year, the DIG software will contain several outcrop studies designated as 'Outcrops that Change the way we Practice Petroleum Geology'," said Jefferis. "Llucmajor in Mallorca and the Sierra Del Cuera in Asturias, Spain are two of the defining outcrops included in the software."

The DIG application was conceptualized by a dedicated group of 15 international geospatial experts and end-users from the geoscience community (AAPG ad-hoc committee) and the prototype was introduced to rave reviews at the AAPG Annual Convention and Exhibition held recently in Calgary.

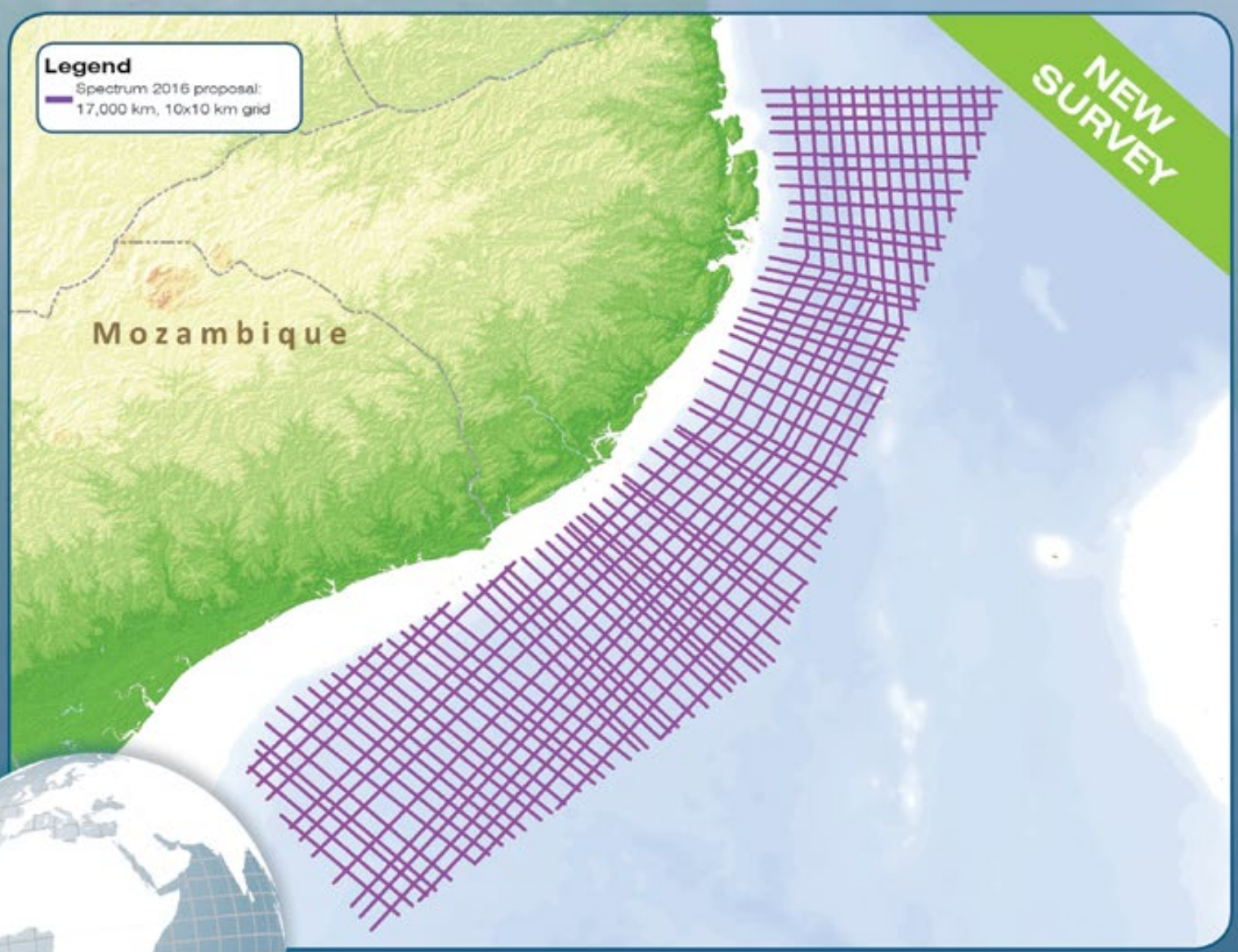
Industry participation is key to the success of this program; therefore, AAPG is seeking industry participation and financial support.

There was a live demonstration at the Geological Society of America meeting Sept. 25-28 in Denver. The full release will be unveiled at AAPG's Centennial Convention in Houston April 2-5, 2017.

multi-client seismic
MOZAMBIQUE

Offshore Mozambique

New Broadband Multi-Client Seismic Survey



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

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

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

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Spectrum

NOCs Strive Through Price, Production Challenges

By EMILY SMITH LLINÁS, EXPLORER Correspondent

Cautious optimism and determination characterized talks at the National Oil Company Forum hosted by Pemex Director General José Antonio González Anaya at the AAPG/SEG International Conference and Exhibition in Cancun recently.

"Pemex has a long term, historic opportunity," González said, referring to Mexico's energy reform that President Enrique Peña Nieto initiated in 2013. He noted how, up until that point, joint ventures in Mexico were both impossible and unconstitutional.

"Before the reform only Pemex could explore, produce, drill and sell petroleum," he said. "Now any company can do so. This is a huge change."

González added that, while he supports the reform, he understands the transition comes at a challenging time for the industry, both in Mexico and worldwide.

"Production has been declining steadily in the past 10 years," he said, "we have to figure out how to produce more."

González spoke following presentations from Ecopetrol, Petrobras and Saudi Aramco executives, each of whom talked about how their companies have made tough choices during challenging price environments.

"I feel like we're not in such bad company," he said.

From left: Ibraheem Assa'adan of Saudi Aramco, Mario Carminiatti of Petrobas, José Antonio González Anaya of Pemex, SEG President-Elect John Bradford, AAPG President Paul Britt, and Max Torres of Ecopetrol.

A Challenging Start

The 49-year-old MIT and Harvard-educated economist joined Pemex in February 2016 when the world oil price hovered around $29 per barrel.

"When I arrived, we had to make drastic adjustments," he said. "We had been planning based on $50 a barrel, which was less than the current price on the global market. We clearly had to make a very large budget cut – about 20 percent of overall budget.

"To you it may sound like every day conversation, for us it was deep change," he said to the audience.

González and his team implemented a series of austerity adjustments and reassessed investments to limit impact on production.

They implemented a new strategy for the Perdido fold belt, a deepwater basin near the U.S. border that Pemex previously planned to develop alone.

"We didn't develop (the basin), and there's no budget to develop it, so we have to find a new way," González said.

The company is preparing to have a joint venture in the basin's Trion field in December.

"Instead of not doing the activity, we are now doing the same activity in a different way, he said. "We are going to do them like everyone else does."

Accelerating Implementation

González's plans include improving Pemex's financial situation.

"We have to accelerate the implementation of the legislative changes that took place, which will help to increase reserves, increase production, improve fiscal regime," he said.

González noted that Pemex has close to 23.9 million barrels of proven, probable and possible (3P) reserves in its 490 assignments. He estimated 500 million barrels of 3P reserves in Trion field alone.

"There's no question that the oil is there," he said.

González described Mexico as an attractive place to do business. The country's proximity to the United States, particularly South Texas, provides advantages. The southern Gulf of Mexico has great potential, though it has not been explored as much as the northern portion.

"When you look at a map, you can tell where the border is because that's where the drilling activity stops," he said, "But God didn't draw the borders."

González said that new partnerships and new technologies will help the company continue to develop the fields in the Campeche Sound, home to the country's emblematic Cantarell well, named after a fisherman who complained about finding oil in the sea.

Pemex has increased investment in the area sixfold in the past 15 years.

See **Global Perspectives**, page 8

AI
from page 3

Machine Learning

Machine learning is a type of artificial intelligence (AI) that endows computers with the ability to learn without being explicitly programmed, and focuses on programs that can teach themselves to grow and change when exposed to new data.

To a degree, it is being used already on 3-D seismic volumes in searching the volume for attributes that can lead to hydrocarbon identification by reviewing more variables than an interpreter can normally view and handle.

But it is not limited to seismic applications. In many areas, particularly in unconventional plays, so much data is being acquired by logs, MWD, pressures, drilling parameters, completion information and production information that the biggest challenge is simply the accumulation of all of this data in a repository that can be used for data analysis. Like nanotechnology, this is a fairly new field.

In summary, there are a few innovative techniques that might lead to common usage in geoscience.

However – as with many innovations – there is likely a technology we are not even aware of right now that could have the biggest impact on our science.

Global Perspectives
from page 6

"Geology gets more and more difficult as time goes on, so you have to look harder and harder," he said. "Perhaps we didn't start early enough; perhaps we did."

* * *

Lowering exploratory risk and maximizing portfolios were common themes throughout the NOC Forum, which featured presentations from Colombia, Brazil and Saudi Arabia.

Ecopetrol: Eyes on the Offshore Prize

Max Torres, vice president of exploration for Ecopetrol, showed maps of company assets in deepwater and ultra deepwater areas of the Colombian Caribbean.

"That is where the action is," he said.

Torres projected that in the next 10 years, Ecopetrol's portfolio will be 50 percent onshore and 50 percent offshore, 50 percent oil and 50 percent gas.

Current activities include preparing to drill a deepwater prospect on the Purple Angel Block, an appraisal well with partners Statoil, Anadarko and Repsol, a new play prospect operated by Repsol and an Ecopetrol operated shallow water prospect in partnership with the Oil and Natural Gas Corporation.

Petrobras: Prioritizing Pre-salt

Mario Carminatti, executive manager of exploration for Petrobras, shared how industry is shifting the focus from production growth to value generation, including competitiveness and cost reduction.

"Petrobras is following the trend," he said. "We are using our extensive database to lower the exploratory risk."

Carminatti described how the company is taking advantage of the outstanding productivity of the country's pre-salt reservoirs, a priority due to their high profitability.

"Pre-salt is the most competitive play in our portfolio," he said, noting that Petrobras deployed more than 1 million barrels per day in pre-salt reservoirs in July 2016.

Carminatti also noted how Petrobras is working closely with Brazil's National Agency of Petroleum, Natural Gas and Biofuels to move the regulatory agenda.

This collaboration is increasingly important as demand rises, Carminatti said, noting that Brazil is the world's fourth largest consumer of automotive fuels.

Saudi Aramco: Unconventional Exploration

Ibraheem Assa'adan, vice president of exploration at Saudi Aramco, shared how his company, which produces one in eight barrels of the world's oil supply, is exploring strategies for staying competitive in changing markets.

He described exploration efforts in Rub' al Khali and the Red Sea, two of Saudi Arabia's least explored areas that have huge potential. There are also challenges, including massive sand dunes reaching up to 700 feet in height, and complex Red Sea bathymetry that makes seismic acquisition and data processing an onerous task.

Assa'adan noted that Saudi Aramco started an unconventional resources program three years ago.

"Gas is becoming a major component of the energy mix, and we're trying to use it as much as we can to substitute other hydrocarbon forms," he said. "We feel it's a matter of time until we get a good handle on the cost."

Aramco is exploring tight gas in the northern part of Saudi Arabia, and they have set up technology development centers across the world to establish a global network.

Continued Partnerships

González said he hopes to see enhanced collaboration in the future.

"It's going to be an interesting time for Mexico, and it's going to be an interesting time for Pemex. That is why we are so excited about being a part of this change."

Gadd with second graders on a field trip in Jasper National Park. Photo by Rob Jolly.

Gadd speaking to students at Central Elementary School in Chilliwack, British Columbia. Photo by Richard Quiring.

A Naturalist's Celebration of Geology

By BARRY FRIEDMAN, EXPLORER Correspondent

"Geology ain't easy."

That's Ben Gadd, one of this year's winners of AAPG's Geosciences in the Media Award.

Gadd, whose book "Handbook of the Canadian Rockies" (which is a bible if you want to know what's going on up there), is a self-described "naturalist."

The term is derived from "natural history" – an idea that goes back to Hutton, Darwin, Huxley and other early British scientists who applied the term to science in general.

Being a naturalist, calling yourself one, says Gadd, is actually a better conversation starter than calling yourself a "scientist."

"When I'm talking about wildflowers and bears, people have no trouble understanding. When I'm talking about thrust faults and ancient supercontinents, it's another matter. This stuff is not intuitive."

Gadd, with his big white beard and broad smile, looks the way a naturalist should. Since 1985, he has been busy producing maps, writing guidebooks, presenting exhibits and making interpretive maps. He believes in the long, deep history of the land and has written extensively about it, including "Geology Road Tours," "Canadian Hiker's and Backpacker's Handbook," "The Yam, 50 years of climbing on Yamnuska" and "Bankhead, The Twenty Year Town."

(The recently updated "Handbook of the Canadian Rockies," by the way, is a comprehensive guide that covers the area from the border of Montana to the Yukon – 831 pages worth.)

Geology's Apostle

Geology needs goodwill ambassadors like Gadd – people who know the science, love it and are willing to take the time to share it with others. In fact, that's very much in line with the mission of AAPG. That, as much as anything, is why he is the perfect recipient of this award – he does it on a daily basis.

"The reward," he said of the work and the people who join him on these treks, "is that they do come along."

And then a marvelous thing happens.

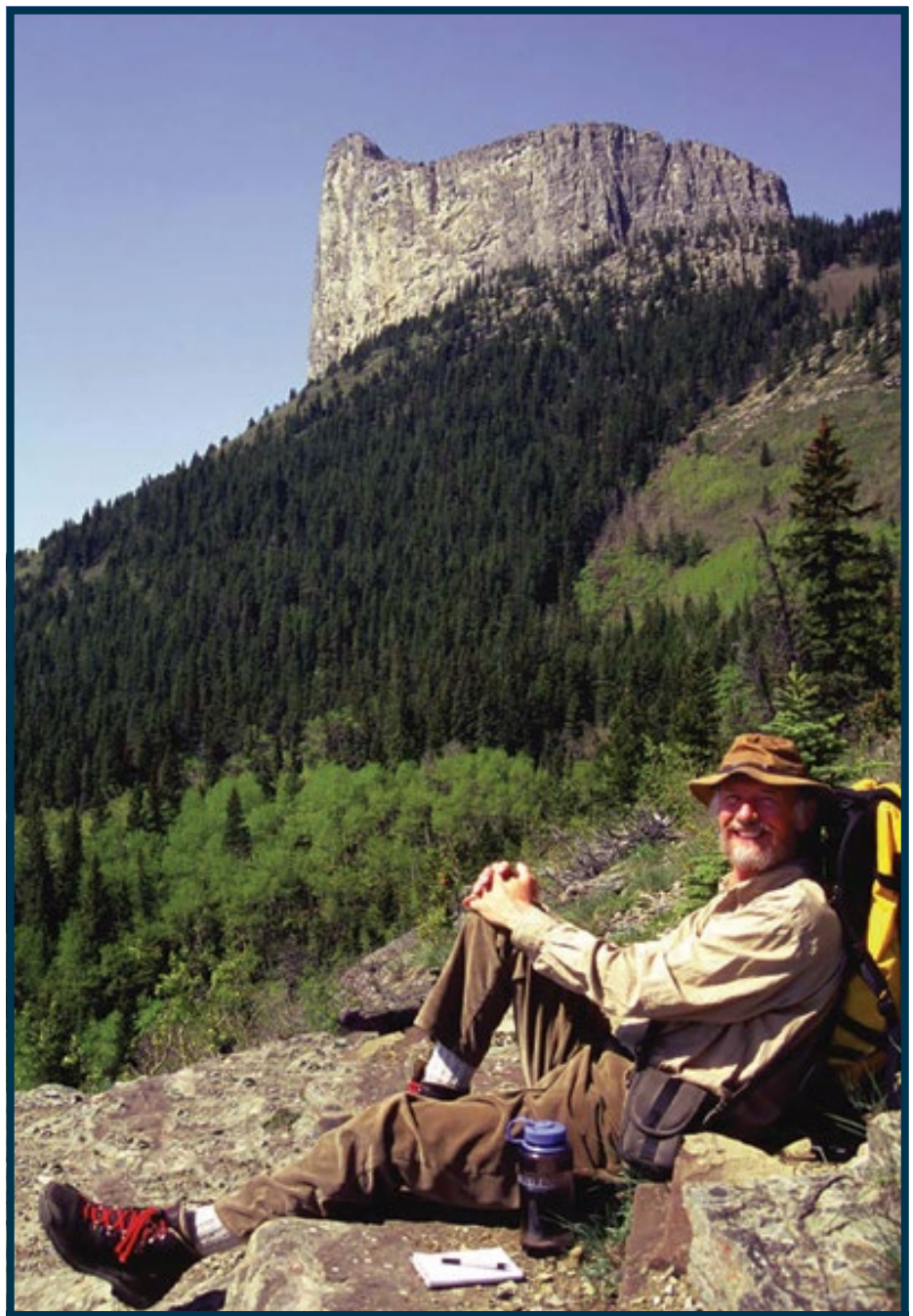
"In fact, when I've spent the day touring Banff National Park with folks who knew little or nothing about the landscape in the morning but are returning to their hotels with their eyes opened to the amazing geological story of that landscape, they can't thank me enough," Gadd said.

His profession, his interest, is an expansive one.

"Nowadays a naturalist is someone with a broad interest in the natural world, especially birds and other wildlife. And naturalists, like those early scientists, are amateurs. Not that a naturalist can't be a professional naturalist. I am. I have written 10 books, all but one of them non-fiction. 'Raven's End' is the exception. It's a story, plain and simple. Ten-year-olds love it (gets read a lot in Canadian schools)."

The book, he maintains, is fiction grounded in fact.

"Throwing in the fantasy aspect, of which there is plenty, made the novel great fun to write – a breath of fresh air."



Gadd resting on the trail to Mount John Laurie, also known as Mount Yamnuska, in the Canadian Rockies. Photo by Chic Scott.

"It is," he said, of all the ones he's written, "my favorite book."

Custodian of the Earth

Talking to Gadd is to understand that the protection, explanation and articulation of our natural history is his life's work – and one he gladly embraces. You can sense his joy. These Rockies, this Earth matters to him.

"When I was born in 1946, there were about 2.5 billion people on the planet. Now there are 7.4 billion. They all need food, water and shelter, and in the process of supplying these essentials the natural world is getting wrecked," he said.

Having lived long enough to see that wreckage, he said, Gadd wishes people were more sensitive to nature.

"But the hard truth is that we cannot stop taking what we need from the Earth's ecosystems, even as they collapse around us. Incredibly, some very far-seeing Canadian politicians saw fit back in the 1880s to protect part of the Alberta and British Columbia Rockies from the predations of their own species."

He is reminded of it everyday.

"I'm lucky and grateful to live in the shadow of great national parks," said Gadd.

The notion of a naturalist winning such a media award might seem a bit anachronistic, if you think about it, for you would expect such a naturalist to eschew the modern trappings of technology. So how does a man with a backpack and a couple liters of water and surrounded by tourists in sneakers and fanny packs get the word out about geology and conservation?

"Well, my 'naturalist' and 'park interpreter' job titles aside, the electronics play a big part in my life. I've been doing stuff with computers since the days everything went in and out on cards. I write on a computer, prepare digital graphics, do electronic layout and give PowerPoint shows. My trusty PC has contributed a great deal toward being honored with this award."

And yet …

"When I'm on the trail in the wilderness I love, there's no smartphone in my pocket. Mama nature has her own way of calling. And being able to answer provides a very special feeling indeed," said Gadd.

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‘Worst Year Ever’ for Exploration

By DAVID BROWN, EXPLORER Correspondent

Can the oil and gas industry innovate its way out of a dismal period for exploration?

And just how bad is the global exploration picture right now, anyway?

Let’s ask Leta Smith, director of upstream energy research for IHS in Houston.


BRINKER

> “Exploration is the first target in cutting back because it’s discretionary, and companies just don’t have the money.”


SMITH

“Discovery volumes have been declining and declining and declining since about 2010,” she said, “and 2016 is shaping up to be the worst year *ever*.”

OK, that’s bad.

Smith keeps tabs on conventional exploration discoveries everywhere around the world except onshore North America. So activity in onshore U.S. and Canadian unconventional plays are outside her frame, although that activity has slowed from a gallop to a trot.

In international exploration, “as of the middle of this year there had only been 2.5 billion barrels of oil equivalent found. That compares with last year, which was a low year. And it was more than double that,” she said.

Risk Aversion

A worrisome trend is the industry’s failure to open up new exploration areas this year, through frontier work or new ideas or innovation, according to Smith.

“I’m sure there are innovations in cost reduction,” she noted.

“But I’m not seeing it in the deepwater basins where most of the discoveries have been made. The innovation seems to be in the unconventionals,” she said.

Companies are managing to lasso in some innovations from other industries, or are extending innovations from unconventional plays, like reduced drilling time, Smith observed.

Other than that, the industry is focused on corralling costs. The biggest players have largely shied away from exploration risk.

“Through May, the majors had found the least of any group. It’s actually the independents who are finding most of it, and that’s been true for the last three years,” she said.

Smith hasn’t been impressed by recent announcements of new finds, although they do offer evidence that exploration still works and remains the best way to bulk up reserves.

Apache Corp. said its Alpine High discovery in the Delaware Basin in Texas could hold 75 trillion cubic feet of rich gas and 3 billion barrels of oil in just the Barnett and Woodford formations, with 2,000 to 3,000 future drilling locations.

And Petróleos Mexicanos has announced several Gulf of Mexico light crude discoveries, off the coast of Tamaulipas and also in shallow waters of the southern Gulf.

But Smith said the Delaware Basin find is in a historically underperforming area and the main Pemex offshore discovery mirrors Perdido Fold Belt wells in the U.S. sector of the Gulf that have been less than exciting.

“I’m not seeing any discoveries in a place where there hadn’t been discoveries the year before,” she noted.

Even the significant new Alaskan oil discovery at Smith Bay, announced by Caelus Energy in October, could be seen as a Prudhoe Bay-Alpine extension.

Large cuts in capital expenditure budgets by almost all upstream petroleum companies darkened the worldwide exploration picture going into this year. A recent industry survey by Deloitte LLP offers both bad and good news.

“Capital spending decisions have been substantially curtailed during the last 18 months, especially for exploration activities. Budgets were directed toward more immediate needs, and external funding sources became less available. For 2016, most (42 percent of respondents) expect capital expenditure to continue declining,” its survey report said.

But Deloitte found that more than 60 percent of industry leaders expect a rebound in 2017 or 2018, with a positive effect on future exploration capital expenditure.

For 2017, “the outlook changes as 43 percent of respondents anticipate capital expenditure to rise in 2017 – optimism for a recovery next year is returning,” it said.

Mountains of Debt

Lysle Brinker monitors exploration investment as director of equity research for IHS Markit in Norwalk, Conn.

“Internationally, in the E&P space very few companies are doing anything in exploration,” Brinker said. “Exploration is the first target in cutting back because it’s discretionary, and companies just don’t have the money.”

Brinker keeps close track of the largest integrated oil companies, especially the Big Five, and he said all of them keep burning through cash.

“They’re really all running structural cash flow deficits,” he noted.

And, yes, that’s bad.

One problem is the amount of debt the largest publicly traded oil companies are carrying.

With lower revenues, the majors have increasingly turned to debt to fund operations. According to the Wall Street Journal, by August this year Exxon Mobil, Shell, BP and Chevron had a combined net debt of $184 billion, more than double their

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Courtesy of IHS.

‘Drone Boom’ Coming to the Oil Field

By BARRY FRIEDMAN, EXPLORER Correspondent

Drones.

They call to mind all sorts of airborne objects, from the strange and ominous to the more workaday and welcome: remote assassins taking out terrorist training camps, quadcopters that drop your Amazon-purchased 90-day supply of Saw Palmetto and case of pizza sauce on your front porch, to those used in geologic mapping and international spying in the field.

There is a veritable “drone boom” afoot in all sectors, from the military to the more mundane, and the oil and gas industry is no exception.

As part of AAPG Geosciences Technology Workshops (GTWs), two courses on the future of drones will help explain how they are going to revolutionize oil exploration.

“Working with Drone Data 101” will be Nov. 30 at the Norris Conference Center in Houston. “New Opportunities with Drones: New Needs, FAA Rule Changes, New Technologies” will be at the same venue Dec. 1-2. Both will discuss the present and future, opportunities and challenges, and the realities and myths of drone technology.

“The two courses,” said Susan Nash, AAPG’s director of innovation and emerging science/technology, are “bridge courses that will help geoscientists put their knowledge to work in a new area – that of surface data derived from remote sensing methods – in this case, from drones.”

Brave New World

The first of these, hosted by Marc Johnson, founder of skynce, LLC, a consulting firm for the implementation of unmanned aerial systems, is “Working with Drone Data 101,” which will serve – as the name suggests – as an introduction to all things drones, specifically what types of data can be acquired by them, including how to use, access and transmit that data through common business platforms such as ArcGIS, Google Earth, SketchFAB and others.

“In this one-day course,” said Johnson, “I will work with the participants to teach them how to leverage drone acquired data in a number of mapping applications.”

The course came about, he said, in response to interest by the AAPG membership for opportunities to learn how this new technology can be implemented in the industry, something Nash said the Association is committed to pursuing.

“AAPG will do whatever we can to introduce new opportunities to Members and to forge new relationships across disciplines to develop new solutions and technologies,” she said.

“Currently,” said Johnson of the technology, “we are seeing increased drone adoption across all industries as technological improvements and regulatory changes usher in a brave new world of drones.”

Regulatory Launch

Jeff Campbell, who will run the “New Opportunities” workshop the following day (Johnson will also participate), said those regulatory changes were significant and profound.

“Prior to August of 2016,” said Johnson, whose company specializes in such technology, “an individual or company had to go through a very lengthy, cumbersome and restricted waiver process, in which the pilot had to possess an FAA manned aircraft license.”

While there were still plenty of operators, last August, the FAA enacted a remote pilot certification process, known as Part 107, which dramatically reduced the time and paperwork required to operate drones.

“Within the first 15 days, over 12,024 applications had been filed, and 5,124 tests had been taken,” he said.

This new regulation, FAA Part 107, is going to dramatically increase the number of commercial drone operators in the United States, so, too, will the opportunities increase.

“I’ll discuss how this lowered barrier to entry is both good and bad news for potential commercial drone operators,” said Johnson. “Over the course of two days, participants will have an opportunity to hear from and engage with the innovators that are currently implementing drones to solve business challenges.”

He added, almost philosophically, “As you look through human history, you can see that mankind has long sought to gain an aerial perspective of our domain.”

While the opportunities are out there, there are concerns as well – some of the “bad news” to which Campbell referred – particularly concerning security and privacy, which tend to happen when you look up and camera-bearing machines are hovering over your garage.

“There are already existing laws

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Privacy
from page 14

concerning invasion of privacy, peeping toms, stalking or unlawful surveillance," said Campbell, "regardless whether it's using binoculars, a ladder over a fence or an airborne drone."

A ladder, binoculars – those were the days, huh?

"Media attention, public misperception and the maturing of laws and court cases associated with any new technology has created an air of uncertainty regarding drone use and capabilities," Campbell said.

Common sense, Johnson emphasized, is the key, meaning, specifically, getting permission from property owners – something he always does when acquiring data to construct a map or a 3-D model.

Initiation

How does all this work, how does one get started?

"The major components," Campbell said, of starting such a drone-based business include:

- Picking a segment of the market
- Choosing equipment
- Training
- Certification
- Marketing
- Product delivery
- Staying in business

It sounds perhaps too easy.

"Well, you can't just pull your drone out of the box, charge the batteries and launch it," Campbell said, adding," or at least you won't, once you quickly have to buy your second one."

He also talked about the wannabe drones in the sky – those lacking range and staying power, as well as your leeway in dealing with them. You can't, for instance, jam their guidance system so they crash or legally shoot them down if they fly over your house.

"They're not really suited for spying on someone's teenage daughter," he said.

That's a relief.

Campbell, a former retired Navy helicopter pilot, who two years ago partnered up with a professional surveyor to start a drone mapping consulting, training and services business, said, "I'm going to be speaking to our experience and covering the changes that our company, Vertical Aspect, has encountered over the last few years, including the regulatory environment."

Johnson, too, has skin in the game. With the new regulations, his company will begin offering its customers Remote Pilot in Command (RPIC) services for hire in addition to the technology consulting services they currently provide.

"The public perception of drones," said Campbell, "has changed significantly over the past three years, from being perceived as an unknown and interesting novelty to – depending on how it's being operated – an irritating, privacy-invading, unsafe flying robot intent upon doing harm. This changing perception must be recognized and mitigated by responsible and safety/privacy conscious operators."

These courses begin the conversation and mitigation.

For the industry, the potential is clear. Nash said, ultimately, the technology will help in the overlooked mature fields.

"It can help determine where to drill to recover the oil and gas that have been left behind," she said.

Innovation
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debt levels in 2014.

Despite a golden period of $100-per-barrel oil, the largest companies have emerged with mountains of debt piled on. That's stomping on the chances for exploration recovery.

"It's a very challenging environment. We keep saying this time it's going to be different because of the massive amount of debt," Brinker said.

The Good News

Maybe the best that can be said about international exploration today is that it hasn't completely dried up and blown away. A few projects aim to build on successes drilled in 2015, or even to test new areas.

"You're still seeing some exploration – the big companies are still drilling some wildcats," Brinker said.

Those include wells in Ecuador, Guyana and Nova Scotia.

"These aren't cheap wells, even with rig rates down," he noted.

The big bright spot seems to be unconventional plays, but most of the innovation there involves stimulation and production – longer laterals, more pressure, faster drilling, multiple wellbores, refracturing jobs.

That kind of forward thinking has helped operators cope with tough-times economics.

"The per-unit cost to add reserves in these liquid-rich unconventional plays has really come down, by as much as $30 a barrel, according to one recent report," Brinker said.

Corruption scandals, government investigations and political roadblocks in several countries also affect the exploration outlook, according to Brinker. Those problems have been compounded by low production prices.

An investigation into widespread corruption charges in Brazil, a major area of exploration in recent years, has handcuffed Petrobras and led to the impeachment of the country's president in August.

"It's still going to take time for things to play out politically and economically in these countries," Brinker noted.

With the industry finishing off a couple of terrible years in international exploration, there's little helpful advice except this: Settle into your saddle and wait for prices to keep rising.

"It's a very unfavorable outlook for new exploration for the next year or two, depending on prices," Brinker said. "If you get up to $60 or even over $55 on a sustained basis, that might be enough to move the needle."

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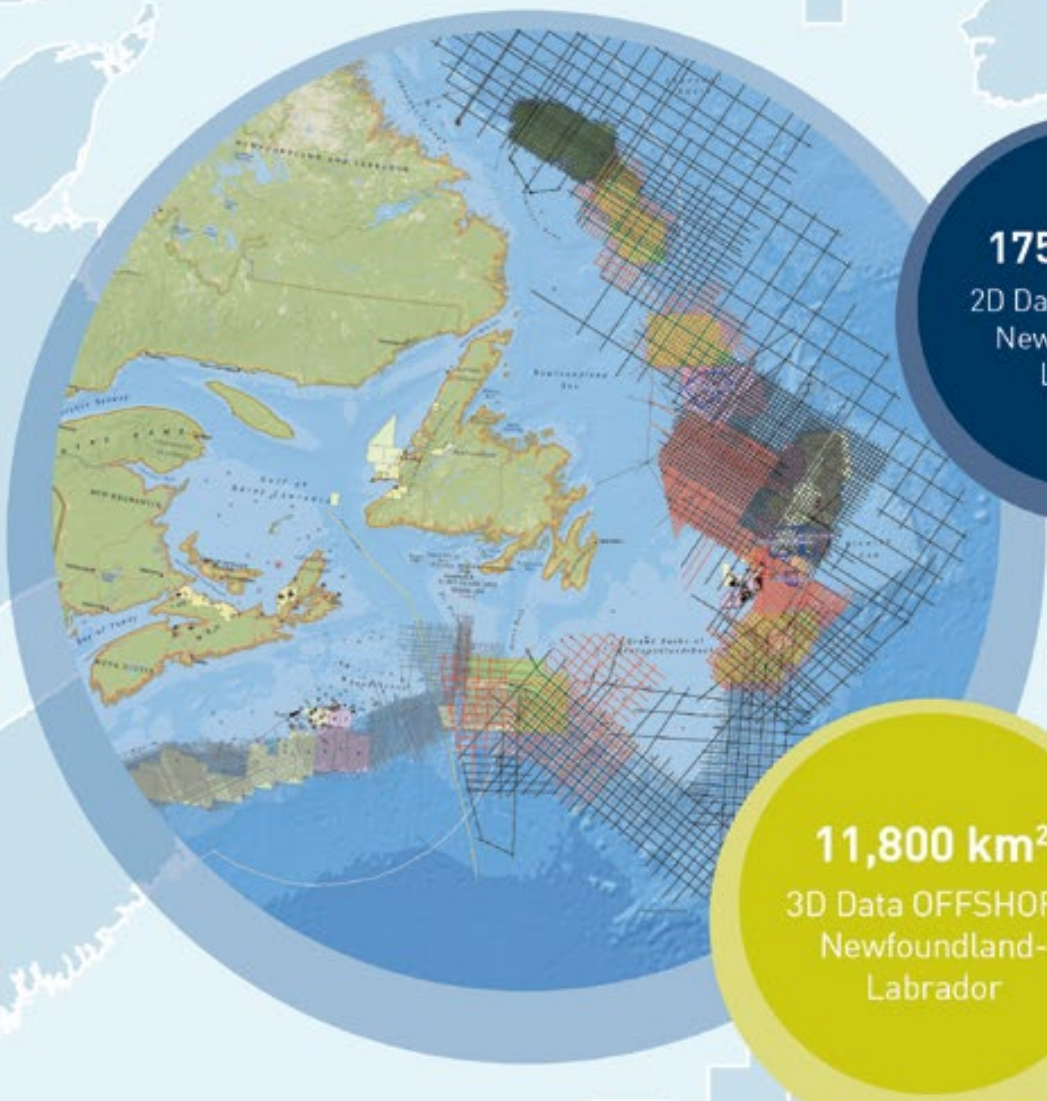

416 Wells
Well data available
LAS+, Check Shot, MudLAS and Directional Survey +

24 Maps
Seismic Facies (SFA) and Play Fairway Analysis (PFA)

112 Wells
Interpreted for sequence stratigraphy and depositional environments (FMB)

101 Wells
Analyzed in the Post Well Analysis (PWA) study

175,000 km
2D Data OFFSHORE Newfoundland - Labrador

53,000 km
2D Data OFFSHORE Nova Scotia

11,800 km²
3D Data OFFSHORE Newfoundland-Labrador

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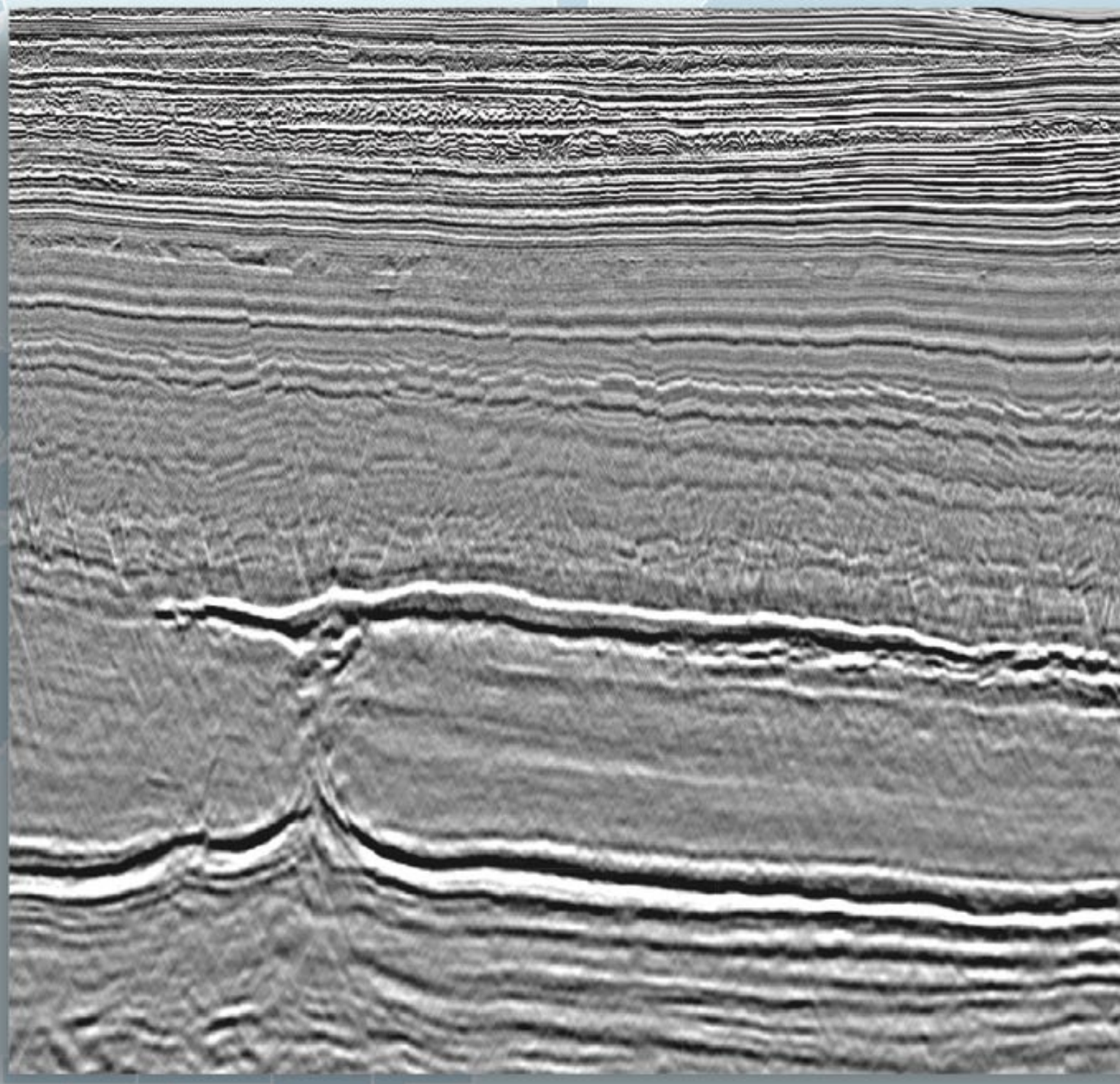
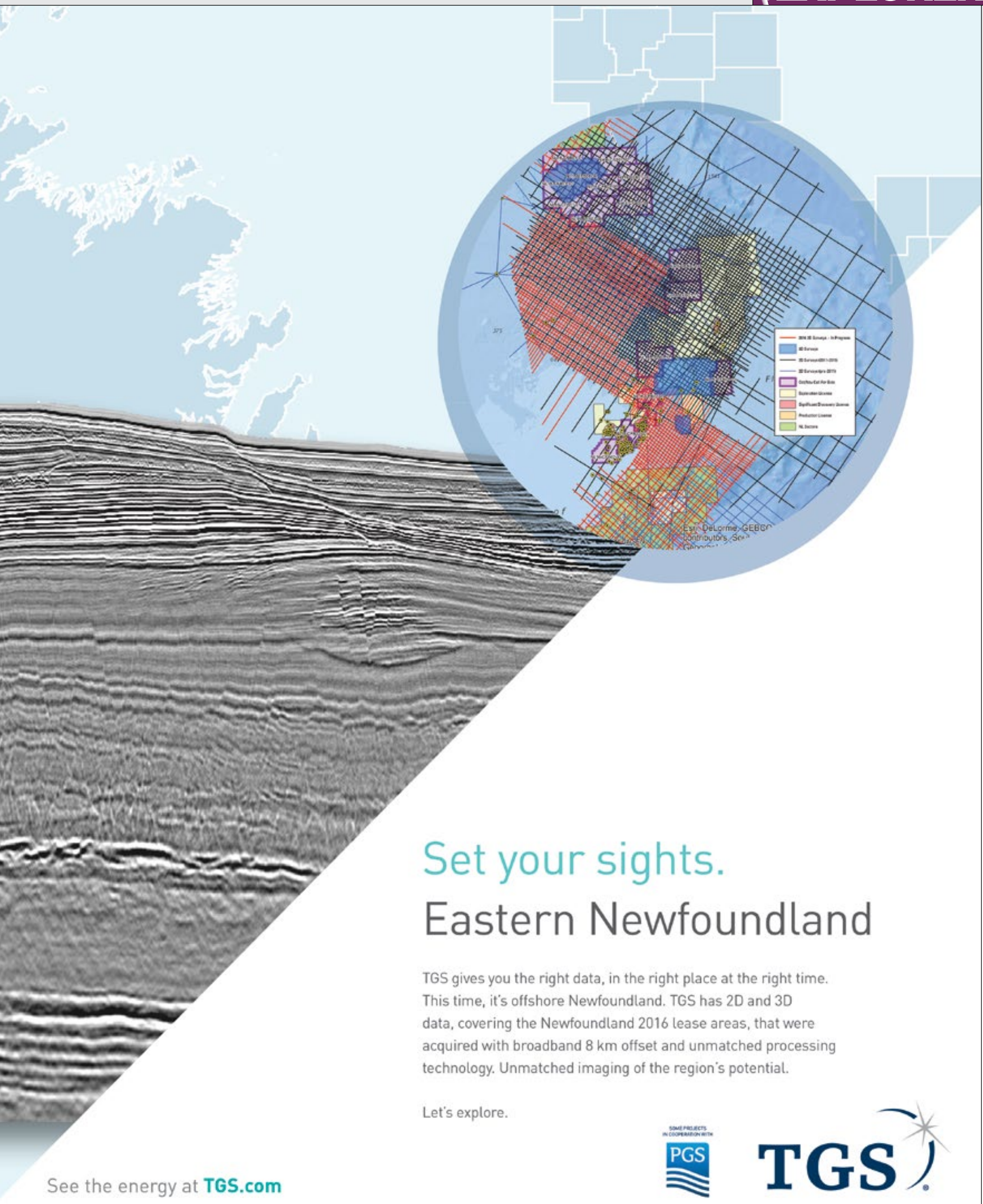
SOME PROJECTS IN COOPERATION WITH PGS

TGS

Kirchhoff PSTM Far Angle Stack





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

Tectonic Shocks in the Oil Industry

By MARK MAU and HENRY EDMUNDSON

The concept of plate tectonics is at the heart of our understanding of petroleum geology today.

Yet, as recently as the middle of the 20th century, most geologists assumed oceans and continents had existed in their locations for much of Earth's 4.55 billion-year history. It was only in the 1960s that new geological, geophysical and oceanographic research proved that the crust of the Earth is made up of about 20 rigid plates that float on the upper mantle and are in constant, albeit slow motion.

Plate tectonics is called the "grand unifying theory" of geology, as it serves to explain a whole range of geologic phenomena. In petroleum geology, it provides thorough explanation for the formation of sedimentary basins where almost all of the world's petroleum occurs. The story of how the concept of plate tectonics was born, struggled, won its fight for existence and eventually arrived in the oil industry is multi-faceted, insightful and entertaining.

The science and ship crew of the HMS Challenger in 1874. The ship's complement included 21 officers and 216 crew members but was reduced to 144 by the end of the expedition due to deaths, desertions, crewmen being left ashore due to illness and planned departures.

Continental Drift Theory

As early as 1620, the English philosopher Francis Bacon noted the similarity between the west coast of Africa and the east coast of South America. Yet knowledge of the constitution of the Earth was scarce for more than two centuries to come. It was the arrival of modern seismology that made the most difference. In 1897, the English geologist Richard Dixon Oldham used a seismograph to monitor a huge 8.1 earthquake in Assam, and this led to his proposal that the Earth consisted of three major components: core, mantle and crust. Twelve years later, the Croatian meteorologist and seismologist Andrija Mohorovičić, following in Oldham's footsteps, postulated the existence of a boundary surface between the mantle and the crust, which came to be known as the M-discontinuity or simply "Moho." In passing through the rocks immediately above this surface, earthquake waves reach a velocity of about 7.2 kilometers per second, whereas below the M-discontinuity, the velocity suddenly jumps to more than 7.9.

These results provided the basis of a wild idea first propounded by Alfred Wegener, a German meteorologist, geophysicist and polar researcher. Using his pioneering interdisciplinary approach, Wegener wrote one of the most influential and controversial books in the history of science: "The Origin of Continents and Oceans," published in 1915. Wegener's idea was that the continents and ocean floors forming the Earth's crust were sufficiently detached from the mantle in order to be able to "float" and move around. He claimed that all the continents had once formed one supercontinent and then, approximately 200 million years ago, split up and drifted away from each other to reach their present form.

Wegener provided five lines of evidence for his so-called "Continental Drift" theory:

- Jigsaw fit, e.g. the coastlines of eastern South America and West Africa are almost perfect counterparts
- Geological fit, meaning the match of ancient rock outcrops on two continents
- Tectonic fit, for instance fragments of the Caledonian fold mountain belt are found in Canada, Greenland, Ireland, the United Kingdom and Scandinavia
- Glacial deposits from the Ice Age about 300 million years ago in Antarctica, Africa, South America, India and Australia
- Fossil evidence, one example being the Lystrosaurus, the "shovel reptile" that was dominant on land in the early Triassic, 250 million years ago. Fossil evidence of the Lystrosaurus was found in Africa, Madagascar, India and Antarctica suggesting these regions once formed one piece of land.

Rejection and Validation

In late 1926, a few years before his death during an expedition to the Greenland ice cap, Wegener was given a forum to make the case for his theory before an international conference organized by AAPG in New York City, where it was almost universally rejected.

In hindsight, it wasn't AAPG's finest hour, but the Association was hardly alone in its collective rejection of Wegener's theory.

The problem was that Wegener hadn't been able to propose a valid mechanism behind the drift.

"A lot of people pooh-poohed it because they wanted to know how it worked," said former Shell geologist Ken Glennie, recalling his student years at the University of Edinburgh during the late 1940s.

John McPhee, the popular writer about geology, remembered when he was a graduate, "Nearly all the faculty at Princeton thought continental drift was sheer baloney."

Former Exxon geologist Walter Ziegler remembered, "When I came to Calgary in 1955, the research department head of Imperial Oil told me that continental drift was European bullshit!"

By that time, clues were beginning to emerge in a discipline closely related to geology – oceanography. This discipline took form thanks to the extraordinarily ambitious British Challenger expedition, which from 1872 to 1876 sailed more than 70,000 nautical miles around the world, taking depth soundings, describing seafloor sediments and identifying thousands of new species. Fifty years later, depth surveys in the Atlantic and Caribbean were revealing a highly irregular seafloor. Especially intriguing, a line of underwater mountains seemed to dot the mid-Atlantic. The picture sharpened after World War I, when echo sounding measurements revealed a long, continuous mountain chain. In the late 1940s and the 1950s, ocean surveys conducted by many nations filled in more detail.

In 1947, Maurice Ewing of Columbia University in New York led an expedition on the U.S. research ship Atlantis and found sediment layers on the Atlantic seafloor to be far thinner than expected. Many scientists believed that the oceans had existed without much change for at least four billion years, so the sediment layer was expected to be thousands of feet deep. The seafloor therefore appeared to be much younger, in the range of 200 million years or less.

Nine years later, Ewing, together with Bruce Heezen, also from Columbia, noticed that earthquakes in the ocean floor predominantly occurred along mid-ocean ridges. In 1962, Harry Hess, a Princeton professor of geology, associated the earthquakes with the idea that ocean crust was forming at the ridges, with molten material such as basalt oozing up from the Earth's mantle along the mid-ocean ridges and spreading new seafloor away from the ridge in both directions. Ocean basins open up between continents that are drifting apart and close between approaching continents.

Hess based his ideas largely on intuitive geological reasoning, and the reactions among his earth scientist colleagues were mixed. They accepted the fact that a great volcanic mountain range encircled the globe, yet rejected the idea of crust moving sideways. For them, the mid-ocean ridge looked rather like a vertically rising welt on a static seafloor.

But then an amazing flood of evidence all but clinched the case in the minds of many geologists.

The most stunning breakthrough came from the University of Cambridge in England. Geoscientists Frederick Vine and Drummond Matthews started looking at the magnetic patterns of the ocean floor. It was well known that the earth's magnetic field had reversed 171 times in the past 76 million years, so it seemed reasonable to observe this record in the vicinity of the Mid-Atlantic Ridge. What they found was crucial. Mirror image records appeared on either side of the ridge, suggesting that the seafloor was not only spreading but also documenting its age. Matthews and Vine published their results in Nature in September 1963,

Continued on next page

Pangaea, the supercontinent, began to break apart 175 million years ago. It was the last supercontinent that existed. This map shows the placement of continents in Pangaea.

MAU

Mark Mau is a professional business historian and writer. He is based in Cambridge (U.K.) and currently working for Schlumberger's corporate communications team.

Henry Edmundson worked more than 45 years for Schlumberger, was founding editor of the Oilfield Review and now runs his own energy consulting business.

EDMUNDSON

Mau and Edmundson recently published the book "Groundbreakers: The story of oilfield technology and the people who made it happen." For excerpts and reviews please visit: history-oil-gas.com.

Continued from previous page

making history.

But other geoscientists had similar ideas. In January 1963, the Canadian geophysicist Lawrence Whitaker Morley submitted a paper to the Journal of Geophysical Research including almost identical ideas, which rejected it summarily. Morley's paper came back with a note telling him that his ideas were suitable for a cocktail party but not for a serious publication.

Waking Up

The Canadian geophysicist John Tuzo-Wilson was also skeptical of plate tectonics but eventually became one of its most famous supporters. He resolved many unanswered questions, particularly the idea of the transform fault in which plates slide past each other without any oceanic crust being created or destroyed. The most famous example is probably the San Andreas Fault between the North American and Pacific plates.

For Walter Ziegler of Exxon, the transform fault concept was a key turning point: "I remember having dinner one evening in the early '60s at the house of Professor Bob Folinsbee at the University of Alberta, and Tuzo-Wilson was there. Tuzo-Wilson was involved in all sorts of oceanographic studies and was the inventor of the transform faults. And there he was sketching it at the dinner table, explaining how it worked. Slowly the American scientific community and the oil community began to wake up."

But it was still proving difficult to establish what the mechanism for the plate movement was. In 1966, 51 years after Wegener clarified the problem, Dan McKenzie had just submitted his doctoral thesis on convection in the Earth's mantle to Cambridge University when he attended a conference in New York, where he heard Fred Vine speak about seafloor spreading and magnetic anomalies. McKenzie applied his knowledge of thermodynamics to the problem of how plates move and came up with a model that demonstrated a far more dynamic Earth than anyone had previously thought. He suggested there are two layers in the mantle, each of which is in motion, controlling the movement and behavior of the tectonic plates above.

The 15 largest tectonic plates in the world. Plate tectonics is the principle that the lithosphere is made up of separate and distinct tectonic plates, which float and move.

"And then the whole thing flipped worldwide," recalled McKenzie, "the only people by the time, by 1968, who still didn't believe there were lateral motions were the old professors running institutes in Russia!"

In the United States, at the Exxon research center in Houston, plate tectonics was finally becoming mainstream. A young geologist, Pete Temple, who had studied under Harry Hess at Princeton, was an early adopter.

Dave White of Exxon remembers, "One day Pete and another member of the group, Tom Nelson, started looking at a seismic section from the Otway Basin off South Australia and they envisioned that what they were seeing was a pull-apart feature, where Antarctica had pulled away from Australia. Applying the theory, they then postulated that there should be a transform fault within a certain area near Tasmania at a right angle from the pull-apart. The fault turned out to be right where they thought it would

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ZIEGLER


WEGENER


TUZO-WILSON

Swiss geologist **Walter Ziegler** worked for Exxon from 1956 to 1983 overseeing the company's exploration activities in many places around the world, including Canada, Greenland, the North Sea, Turkey, the Middle East, Libya and offshore west Africa.

German scientist **Alfred Wegener** is most remembered as the originator of the theory of continental drift, the precursor of plate tectonics. But during his lifetime he was primarily known for his achievements in meteorology and as a pioneer of polar research. Wegener was involved in several expeditions to Greenland to study polar air circulation. Expedition participants made many meteorological observations and achieved the first-ever boring of ice cores on a moving Arctic glacier.

Canadian geophysicist **John Tuzo-Wilson**. From 1946 until 1974, he worked as a professor at the University of Toronto and is regarded as the father of academic geophysics in Canada.

This rock outcrop in Iceland is a visible portion of the Mid-Atlantic Ridge and is the easternmost edge of the North American plate. Today, it's a popular destination for tourists in Iceland.

British geoscientists Frederick Vine and Drummond Matthews. Matthews was Vine's doctoral supervisor at the University of Cambridge when they published their path-breaking contribution to the evolving concept of plate tectonics in 1963.

Application
from page 21

be. I remember Pete coming into my office waving the seismic section in the air. He thought that was pretty neat, and I did too."

This was probably one of the oil industry's first practical applications of global tectonic theory, in terms of making a prediction of a structural feature.

"This then gave us an idea of basin-forming tectonics and what converging plates and diverging plates did to basins. So, plate tectonics gave us a real handle on how to identify how basins were formed," said former Exxon geologist Dave Kingston.

By the late 1970s, the usefulness of the plate tectonics concept was starting to be realized by many geologists in the industry, such as John Rogers of Atlantic Richfield Company who in 1977 praised the concept in an Offshore Technology Conference paper: "The implications of plate tectonics for exploration is significant. Knowledge about timing of structural growth, and distribution of reservoir and source rocks is vital to an exploration program. Plate tectonics is not an oil finding tool but a unifying concept to which one may relate the required interpretations about structure and stratigraphy."

Ever since the 1970s, the application of plate tectonic concepts has enabled explorers to extend the plays off the coast of Brazil, such as the Campos and Espirito Santo basins (discovered in 1969 and 1974, respectively), across the Atlantic to offshore western Africa. Within the last two decades, exploration companies have applied principles of plate tectonics to extend and relate upper Cretaceous turbidite fan plays westward – from West Africa across the Equatorial Atlantic to French Guiana and Brazil.

Today, the concept of plate tectonics is an integral part of oil and gas exploration, forming a core element of software applications such as the Neftex Earth Model. Neftex is a U.K.-based geoscience consultancy, established in 2001 and since 2014 owned by Halliburton. It is the brainchild of three former BP geologists – Dave Casey, Roger Davies and Peter Sharland – who realized that collecting, accessing and integrating data have become the key to success in exploration.

The Earth Model connects multiple regional models. Through detailed evaluation of the geologic record of the world's major sedimentary basins using every piece of publicly available data they could lay their hands on and leveraging the sequence stratigraphy approach Casey and his colleagues have identified, correlated and mapped more than 100 depositional sequences around the world ranging in age from Late Precambrian to Pliocene. The range of data runs the gamut of anything that's geologically relevant, including surface field studies, paleontology, geochemistry, logs and more. And by linking these modern-day correlations to a tectonic model of the major continents that can wind back 600 million years, the entire geodynamic relationship between the Earth's plate tectonic history and the occurrence of hydrocarbon deposits can be viewed and analyzed.

AAPG Education Upcoming Education Events 2016

GEOSCIENCES TECHNOLOGY WORKSHOP

New Opportunities with Drones: New Needs, FAA Rule Changes, New Technologies

1-2 December 2016 | Houston, Texas

Commercial opportunities for drones are headed for explosive growth thanks to new technology and regulations (Rule 107) which are removing many barriers to entry and are expanding their applications. Drones are used in the oil and gas industry from upstream to downstream, and in many other industries.

But, how do you get started? Or, if you have commercial drone/Unmanned Aerial Systems (UAS) operations, how do you expand your business? Welcome to a workshop in which we will bring together experts, equipment providers, robotics experts, and others knowledgeable in a wide range of commercial drone usage, which includes monitoring in the oil industry, digital outcrop surveying, safety and security monitoring, utility inspection, real estate, agriculture, construction, environmental protection, and more.

Deepwater and Shelf Reservoirs: New Technologies for New Understanding

24-25 January 2017 | Houston, Texas

The goal of this event is to bring together new technologies and developments in both exploring for new frontiers and developing known provinces in both deepwater and shelf environments. The event brings together geology, geochemistry, engineering, and geophysics.

Proposed topics for presenters:

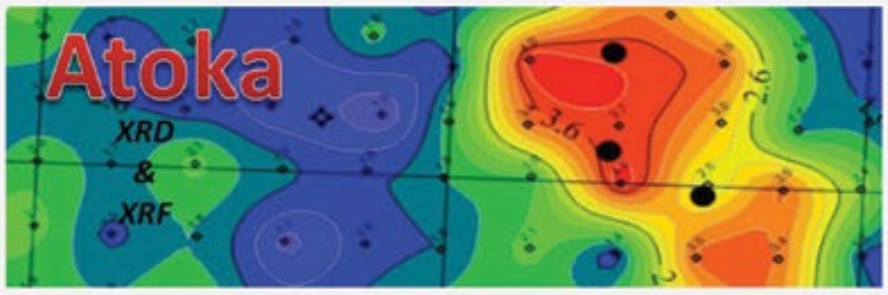
- Depositional environments
- Basin modeling and new frontiers
- Complex depositional systems
- Imaging and developments in seismic interpretation
- Salt behavior and new techniques for imaging
- New technologies in data acquisition and processing
- Geochronological determinants, including detrital zircon
- Reservoir characterization and connectivity
- Borehole stability and pressure modeling
- Beomechanical modeling and understanding pressure in reservoirs
- Assessment phase and improvements
- Planning reservoir development
- Tying reservoir measurements with characterization and production planning

If you'd like to share your knowledge and be a part of this workshop, please contact sbrown@aapg.org.

SHORT COURSES

Use of Surface Geochemistry in Petroleum Exploration

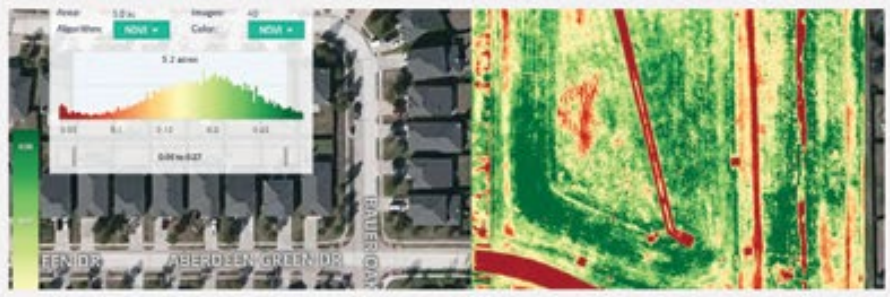
29 November 2016 | Houston, Texas



This course will present a one day discussion of the use of surface geochemistry in petroleum exploration for conventional production. Topics will include theory of vertical migration, optimal sampling methods, caveats, statistical analysis of data, radiometrics, iodine, soil gas, petroleum fluorescence, microbial, XRF and trace metals to locate areas of micro-seepage. Several case histories are integrated with seismic and subsurface geology both domestically and internationally.

Working with Drone Data 101

30 November 2016 | Houston, Texas



In this course participants will learn about the types of data that can be acquired by drones, render that data into 3D models, orthomosaic and NDVI maps, and import the rendered data into business platforms such as ArcGIS, Google Earth, and SketchFAB. This is an interactive course where students are encouraged to bring their own drone data problems.

FIELD SEMINAR

Astrogeology Total Solar Eclipse 2017 Field Seminar

18-22 August 2017 | Casper, Wyoming

We will be in Casper, Wyoming to see the rare total solar eclipse of August 21, 2017, learn basic astronomy through presentations and star gazing, and do field geology at world class paleontology sites and a documented terrestrial impact site. Casper is also home to historic petroleum geology sites such as nearby Teapot Dome. Jack Schmitt and Jim Reilly will be at the eclipse event to discuss the challenges of a manned mission to Mars and a return to the Moon to embark on a new energy frontier with He-3 fusion.

www.aapg.org/career/training/

The Geophysical Corner is a regular column in the EXPLORER, edited by Satinder Chopra, chief geophysicist for Arcis Seismic Solutions, TGS, Calgary, Canada, and a past AAPG-SEG Joint Distinguished Lecturer.

Enhancing the Quality of Seismic Impedance Data

By SATINDER CHOPRA, RITESH KUMAR SHARMA, REBECCA DANIELS, BRIAN SCHULTE, JIM PULLISHY and TAMMY CHOW

Raw seismic data are almost always found to be contaminated with coherent or incoherent noise. Concerted efforts are directed at elimination of such noise during processing of the seismic data, so that its interpretation can be carried out accurately. These efforts are more relevant for stratigraphic interpretation and where amplitude analysis is the end goal. Usually the coherent noise trains seen on seismic shot records are eliminated early in the processing, and the subsequent processing steps address any residual incoherent noise component that may persist. This strategy works well in most cases.

If acquisition footprint is present in the data, it can be noticed on the vertical and horizontal displays of seismic data. If it is not suppressed, then later any attribute work done on such data only accentuates it further, and masks its meaningful interpretation. An article of Geophysical Corner, published in the December 2014 issue of the EXPLORER by Chopra and Kurt Marfurt, discusses ways to address the suppression of acquisition footprint from seismic data.

But sometimes the low-frequency linear dipping noise is present in the final processed seismic data, and yet goes unnoticed. When such data are worked upon in terms of generation of seismic attributes, the dipping noise can be seen clearly on both vertical and horizontal displays. Another aspect of which some interpreters are aware is that sometimes seismic attributes, when displayed in colored variable density, may not exhibit certain noise patterns – the dipping noise patterns being one of them. But such dipping noise patterns may be seen clearly when the same data are displayed in variable density gray scale.

Noise on Seismic Attribute Data

The post-stack or pre-stack impedance inversion is a typical common seismic attribute generated from seismic data. Both of these methods have been discussed in separate articles of Geophysical Corner published by the first two authors of this article in the May and June 2015 issues of the EXPLORER. We illustrate the above aspect on a segment of an impedance section from west-central Saskatchewan, Canada. It was generated using pre-stack simultaneous impedance inversion and is shown in figure 1, where figure 1a shows the section in color and the same data is displayed in gray scale in figure 1b.

Notice the low-frequency dipping noise patterns indicated with yellow and blue arrows. When we examine the two displays carefully, we notice that the impedance values are affected by the linear noise in terms of their lateral variation. A wormy variation in impedance values is seen in figure 1a in green and red wherever the noise patterns are present and seen in gray scale in figure 1b. This low-frequency dipping noise needs to be filtered out of the data in such a way that the amplitudes are not affected.

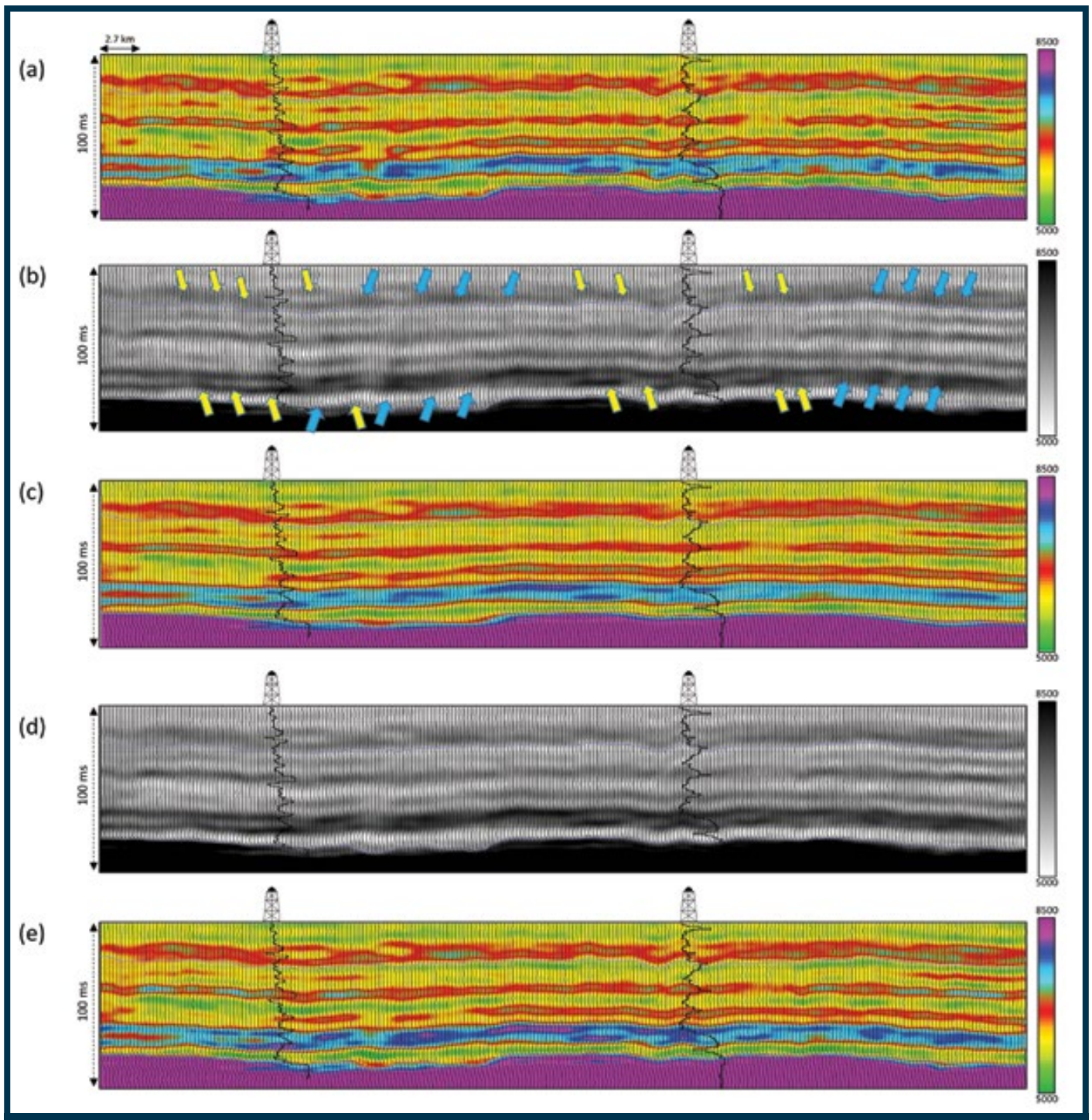


Figure 1: Segment of an (a) inverted impedance section displayed in color; (b) the same section in (a) displayed in gray scale; (c) when the impedance data volume from where the representative section is shown in (a) was dip-filtered (after simultaneous inversion). Notice the lowering of frequency and smoothed events on this section. (d) the equivalent impedance section to data shown in (a) shown in gray scale, but inversion performed on the near-, mid- and far-angle stack data that was put through controlled-dip filtering; and (e) the same impedance section shown in (d) in color. Notice, no low-frequency dipping seen on the gray-scale display shown in (d) and the quality of the impedance section looks much better than the equivalent section shown in (a) or (b).

Filtering Out Noise from Seismic Data

For coherent noise suppression from seismic data, a class of methods exists wherein the input seismic data are transformed from the x-t domain into a different domain using a mathematical transformation. A domain to which the seismic data is commonly transformed is the frequency-wavenumber or the f-k domain by using Fourier transforms. The seismic signal and the coherent noise that appear tangled up in the x-t domain get separated in the f-k domain. The low-frequency dipping coherent noise maps close to the wave number axis, and the seismic signal maps close to the frequency axis. Now the undesired component in the data is muted, and the remaining data transformed back in the x-t domain. The other domains to which seismic data in the x-t domain can be transformed are the tau-p (using Radon transform) and f-x (using Fourier transform) domains. A concern some analysts have in such cases is that some signal can leak through the removed component, especially when the noise and the signal are not well separated in the transformed space, so that the method may not be an amplitude-friendly process after all.

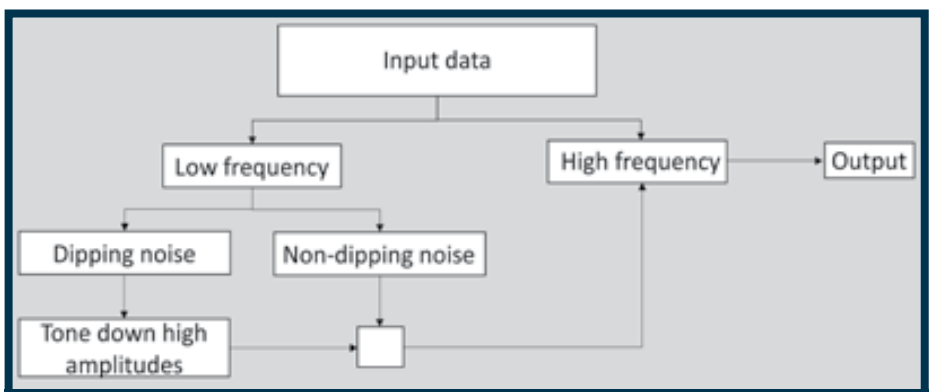


Figure 2: Workflow for controlled dip-filtering that was performed on the near-, mid- and the far-angle stack seismic data, before running simultaneous inversion.

A different workflow illustrated in figure 2 can be followed in such cases. We begin by first separating the data into the low- and high-frequency components, the former encompassing the frequency range of the dipping noise in the data, which is under discussion in this article. Next,

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CHOPRA


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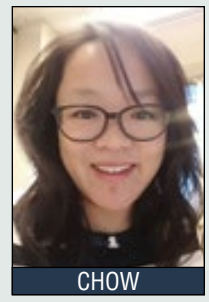
DANIELS


SCHULTE


PULLISHY


CHOW

Ritesh Kumar Sharma is with Arcis Seismic Solutions, Calgary, Canada, and is a regular contributor to Geophysical Corner.

Rebecca Daniels is a professional geophysicist with a bachelor's from the University of Calgary. She joined Talisman Energy after graduation in 2008 and is currently working for Repsol Canada as a development geophysicist in the Chauvin area of west-central Alberta.

Brian Schulte attended the University of Calgary graduating with a bachelor's in geology with a minor in geophysics in 1989. He has worked both in Calgary and Houston for various companies including Geco-Prakla, Vastar Resources, BP, Explora Seismic Processing, Geokinetics, Talisman and currently is working for Repsol as a geophysical adviser working on projects associated with quantitative interpretation, quality assurance, mentorship and technical developments.

Jim Pullishy first encountered the oil and gas industry as a legal surveyor during the boom years of the '70s locating well sites and pipelines in Drayton Valley and Fort McMurray, after studying survey technology at the Northern Alberta Institute of Technology. Subsequently he graduated with a bachelor's degree in geophysics from the University of Calgary. His more than 30-year career since then has included initial stints supporting the first generation of interpretive workstations and seismic processing, followed by a lengthy focus on seismic interpretation to generate exploration plays. Pullishy has worked on exploration opportunities on most continents, and his work has taken him from the high Arctic to the tropics. He is currently working at Repsol as a geophysical adviser in the North American regional unit.

Tammy Chow graduated from the University of Calgary in 2006 with a bachelor's degree in geophysics. She has since been working with Talisman Energy – now Repsol Oil and Gas Canada – in a number of areas and positions. She currently works on the petrotechnical team.

Continued from previous page

the suppression of the dipping noise is affected by one of the available methods including the f-k filtering described earlier, and subtracted from the input data. Besides the residual dipping noise, this data may contain some residual signal that may have leaked through the filtering process. The higher amplitudes of the dipping noise component are then toned down. The residual component so obtained is added back to filtered low-frequency component and the high-frequency components of the input data. We refer to this workflow as a controlled dip-filtering process.

One could think of running the controlled dip-filtering workflow on the impedance data shown in figure 1a and b. We show the results of such an application in figure 1c. Notice the overly smoothed appearance of the data, which may not be acceptable to the interpreters, for good reason. Not happy with the result, we go back to the input seismic data, which are the near-, mid- and far-angle stacks generated for performing simultaneous inversion and put them through the controlled dip-filtering workflow shown in figure 2. The dip-filtered angle stacks are then put through simultaneous inversion. The impedance section equivalent to figure 1b is shown in gray scale in figure 1d, where the low-frequency dipping noise is no longer seen. No artifact of the dipping noise is seen on the equivalent section shown in color in figure 1e. We thus conclude that the quality of the impedance data is much better now.

Conclusion

The low-frequency dipping noise, if present in the input data, needs to be handled with care and in an amplitude-friendly way before impedance inversion, or for that matter before any attribute computation is carried out. When the P- and S-impedance data derived from simultaneous inversion are free from noise artifacts, we ensure that the subsequent elastic parameter attributes are of good quality and thus amenable to more meaningful interpretation.

Acknowledgements

We thank Xinxiang Li for useful discussions and Repsol Oil and Gas Canada Inc. as well as Arcis Seismic Solutions, TGS, Calgary for permission to publish this article.

Downturn Drives 'Outside the Industry' Tech Innovation

By DAVID BROWN, EXPLORER Correspondent

In a remote area of Alaska, almost 600 miles north of Anchorage, a field inspector checks an array of oil and gas production equipment.

The inspector is examining an assigned grid of territory extending from Prudhoe Bay across the North Slope inlets, traveling over a rugged expanse of ponds, boulders and barren landscape.

Without regard to the bitterly cold weather, the inspector hovers over the equipment installation, capturing data and recording images.

Yes, literally hovers, because this inspector is a drone.

"In terms of making things more efficient, you're starting to see these digital technologies like drones and AUVs (autonomous underwater vehicles) being used," said Carolyn Seto, director of upstream technology and innovation for IHS Markit in Cambridge, Mass.

Drones can be used for everything from mapping to equipment surveillance, AUVs for everything from environmental surveys to checking underwater currents. They're a boon to deepwater exploration, Seto noted.

"You can make the most of the time you have out there," she said.

Exploration innovation in an industry downturn turns out to be much more targeted. More cost-conscious. Edgier.

"The downturn has really focused companies in allocating for what they want to innovate on. There's more of a focus on, 'What are the technologies we need now?'" she said. "Another thing we've seen from the downturn is a lot more interest in collaboration."

SETO

> "Maybe 10 years ago, the industry was very closed, thinking that the best innovations came from inside the industry. Now there's the belief that good ideas can come from anywhere."

Partnerships and venture groups are helping companies maximize their technology development dollars, Seto said. Also, exploration today is more willing to draw on innovations from other industries.

"It's more taking some of these proven technologies from other areas, like the consumer segment, and bringing them into the exploration arena. In the case of drones and virtual reality and data analytics, those techniques were really perfected from the consumer industry," Seto noted.

"Maybe 10 years ago, the industry was very closed, thinking that the best innovations came from inside the industry. Now there's the belief that good ideas can come from anywhere," she said.

Rise of the Machines

Seto sees big changes coming to oil and gas in three areas:

- Greater automation in the field
- Use of robotics in operations
- Advanced data analytics used in proactive ways

"In mature fields, in these operations that have decades of operation or hundreds or thousands of wells, you're starting to see a shift toward using statistical models to operate the fields," she said.

"Now we're getting so much more data from our operations, not just technical data but data about the process. Because we have that transparency into operations, decisions are becoming more data-driven. This is leading to more cooperation among the disciplines," she observed.

Data captured from operations can be processed for advanced analytics, a decision-support tool, as well as predictive analytics, Seto said.

According to the technology firm Gartner Inc., advanced analytic techniques include "data/text mining, machine learning, pattern matching, forecasting, visualization, semantic analysis, sentiment analysis, network and cluster analysis, multivariate statistics, graph analysis, simulation, complex event processing, neural networks."

"Advanced analytics is being used quite successfully in drilling and completion, while predictive analytics is being used in things like equipment maintenance," Seto said.

Strangely, one innovation mostly left behind in the rush to automation and data analytics is the idea of the intelligent field – the "iField" or "Field of the Future" concept.

"There's less interest in that now, partly because those projects have been implemented and have reached a barrier," Seto said.

Five Technologies for the Coming Decade

In September, the international management consulting firm McKinsey & Company issued a report titled "Five Technologies for the Next Ten Years," listing technologies expected to affect the oil and gas industry during the coming decade.

Richard Ward, senior expert, and Scott Nyquist, senior partner, both with McKinsey's office in Houston, were two of the co-authors of the report.

Ward said exploration has been the most digital industry on the planet in many ways and observed, "The oil and gas business might be the most valuable digital industry in history."

He put the accumulated value of technology-enabled oil industry operations at $40 trillion to $50 trillion.

According to the report, these five technologies will change the way the industry operates in the future:

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1. Mobile

Mobile technology will let technicians understand a project, accept an assignment and file a work report when they have finished, "no matter what time it is or where they are."

"The ability to provide connectivity to smaller and cheaper components, in more and more remote areas, continues to grow. We expect that by 2025 every well in the Western Hemisphere will have access to 4G cellular at a cost-competitive rate," the report said.

2. The Internet of Things

Equipped with electronics, software sensors and Internet connections, this network of physical objects will collect and exchange data.

"We keep thinking that you won't be able to buy a toaster that won't be connected in some way," Ward said.

A $30,000 or $40,000 piece of equipment will definitely want to be connected, he noted. The industry already has many networked sensors for remote monitoring and control of refineries, pipelines, pumps and platforms.

As the cost of sensing and connecting continues to drop, more and more interconnections will occur.

3. Machine Learning

Through machine learning, computers can understand how to do something without having been programmed to do it. When a computer can teach itself new strategies based on experience, its analyses will improve over time without the need for human intervention.

Ward gave the example of a computer-assisted seismic interpretation system that will both learn and suggest best practices.

"If previously you had to have an expert who would program things into a system, now you'll have a system observe how 500 interpreters around the world are doing it," he said.

4. Robotics

If you've been wondering whether robots will take over the world, the answer is: "Yes."

Robotics has "undergone dramatic changes in the last five years," the report stated.

"We expect that the number of robotic systems working in oil fields around the world will be nearly a million by 2025. Some will live permanently at a facility such as a refinery, while others will be a part of a technician's toolkit," it said.

5. Blockchain

A digital ledger approach to recording financial transactions, Blockchain is poised to simplify contracting and transacting everywhere, Ward and Nyquist believe.

Blockchain was first used as the underlying technology for bitcoin in 2009.

"In the oil and gas industry, anywhere a contract for performance is required there is a chance it will migrate to a blockchain-enabled agreement. Such contracts may include land royalty, production sharing, or service-execution contracts," its report said.

Automation Now

Seismic acquisition will be one of the first areas to benefit from enhanced automation, Ward predicted. Offshore, semi-autonomous drones for positioning could make sure streamers are exactly parallel to ensure the fidelity of data capture. On land, each geophone could be its own quadcopter.

"That would give you much better fidelity on 3-D data capture and at much lower costs, because you don't have to be putting roads through people's property. One of the things farmers and ranchers are unhappiest about is people carving out roads and cutting through their land," he said.


WARD


NYQUIST

Another change Ward expects is growth of the "angels-on-their-shoulders" concept, in which oil and gas professionals increasingly will be assisted by expert systems. A program might ask, "Didn't you mean to make that pick a couple of pixels over?'" he said.

"That concept is going to start percolating itself more and more into knowledge work, especially into interpretive work," Ward said.

Better Efficiency, More Fun

Technological advances and applications promise to make the oil and gas industry not only more effective, but also more efficient and productive.

"From a senior management point of view, this will show up as a step-change in productivity," Nyquist said.

The move to advanced technology reflects the change in an industry that's going through what has been called the "Great Crew Change" or the "Big Replacement."

"Many geoscientists that have learned a certain way of using technology on the job are finding out that these technologies are changing. There is a generational shift taking place," Nyquist observed.

Ward said the good news for geoscience professionals is that these new technologies can reduce the drudgery of routine and repetitive tasks.

"What we're seeing is that many of these tools can make a certain amount of that fade into the background. I really, fundamentally believe these technologies will bring more fun to the job," he said.

Will the coming technology changes be revolutionary?

It's happened before, Ward noted.

He said we're now "holding a four-inch piece of glass in our hands and can look up anything we want to at any moment. The iPhone was released in 2007, so about 10 years ago. And this has literally changed the world."

With so much added capability in data capture, interconnectedness and automation, are we headed toward a peak of data use in exploration?

Seto doesn't see it that way.

"I think we're just scratching the surface of this," she said.

Edith Allison, director of AAPG's Geoscience and Energy Office in Washington, D.C., can be contacted at eallison@aapg.org; or by telephone at 1-202-643-6533.

Chasing Fugitive Methane

By EDITH ALLISON, Geoscience and Energy Policy Office Director

Some environmentalists have argued that high levels of methane leaks and emissions make natural gas a poor alternative to coal for generating electricity. However, total greenhouse gas (GHG) emissions – carbon dioxide, methane, nitrogen oxides and some fluorinated gases – have declined as natural gas has replaced coal in power generation. However, atmospheric methane continues to rise and the scientific evidence is unclear on whether oil and gas operations are the source of the increase. These emissions analyses take on added importance because the Obama administration is rushing to enact additional oil and gas industry regulations to help meet the President's Climate Action Plan (CAP) goal of reducing methane emissions by 40 to 45 percent below 2012 levels by 2025.


ALLISON

Mitigating fugitive emissions requires knowing where or what they come from. However, identifying the source is difficult.

State of Emissions

The White House recently reported, "U.S. carbon dioxide emissions from the energy sector fell by 9.5 percent from 2008-15, and in the first 6 months of 2016, they were at the lowest level in 25 years." The Council of Economic Advisers credited the shift to natural gas for 66 percent of the carbon emissions reduction, while increased generation from zero-carbon renewable energy provided 34 percent of the reduction.

In addition, Energy Secretary Ernest Moniz recently reaffirmed his support for hydraulic fracturing, saying the natural gas boom has been good for the environment, "displacing high-carbon coal with natural gas producing fewer emissions."

Looking just at anthropogenic methane, sources include domestic animals (including manure management), the oil and gas industry, landfills, rice cultivation, wastewater, coal mining and biomass. Wetlands are the dominant natural methane source. However, geologic sources – thermogenic and biogenic methane produced in the Earth's crust and released into the atmosphere from land and submarine faults and seeps – may be significant although they have not been comprehensively measured.

Global atmospheric methane concentrations increased during most of the 20th century, excluding the period from 1999 to 2006, when atmospheric levels stayed level. Methane levels have increased since 2006, and the 2015 level was about 1800 parts per billion – up from about 1700 ppb in 1988. The major concern is that there is not a scientific consensus on the cause of the renewed increases.

Identifying Sources

To state the obvious, mitigating fugitive emissions requires knowing where or what they come from. However, identifying the source is difficult. In many oil and gas-producing areas, potential sources may include livestock, coal mines or waste treatment facilities. An additional complication is that methane detection has been conducted using a hand-held or vehicle mounted detector or sampler at a small number of facilities. Airborne sampling – primarily done with National Oceanic and Atmospheric Administration airplanes – captures methane from all sources and must also be corrected for wind and weather conditions.

A recent American Chemical Society report by David Allen details one of the major problems impacting methane emission estimates: "estimates based on source sampling extrapolated to regional or national scale ('bottom-up analyses') differing from estimates that infer emissions based on ambient data ('top-down analyses') by 50 percent or more."

Here are some of the recent studies on possible causes of the recent increases in atmospheric methane:

- A September report in the Proceedings of the National Academy of Sciences by Andrew Rice and others uses isotopic studies to find that "methane emissions from the fossil fuel sectors were approximately constant in the 1980s and 1990s but increased significantly between 2000 and 2009."
- A recent study by atmospheric scientists in New Zealand, Germany and the United States (Schaefer et al., 2016) found that increases in atmospheric methane were not caused by fossil fuel production, but more likely from wetlands or agriculture.
- Another recent study from the Royal Holloway, University of London (Nisbet et al., 2016) found that the increase in atmospheric methane from 2007 to 2013 was dominated by significant increases in biogenic methane emissions, especially from wetlands, ruminants and rice paddies in the tropics.
- Amy Townsend-Small presented data at the 2016 Eastern Section AAPG

See **Emissons**, page 32

PROTRACKS

Catching Up With the Eastern Section YPs

By MERRIL STYPULA, Eastern Section Young Professional Liaison

The Eastern Section Young Professional network is composed of a growing number of early career geoscientists spanning 23 states, Washington D.C. and Ontario, Canada. Currently, the bulk of our activity stems out of Pittsburgh. However, the early career geoscientists of the Eastern Section are excited to begin expanding their network into other Eastern Section cities.

A Look Ahead, and Back

For the year to come, the Eastern Section YPs have three goals:

- Establish two additional Eastern Section YP chapters in an effort to support a broader geographic range of YPs in our Section.
- Recruit three dedicated and enthusiastic YPs to co-chair Eastern Section committees.
- Work with Eastern Section leadership to educate our Student and YP Members about the different levels of AAPG membership, as well as the benefits of maintaining an active role within our organization.

Over the past year, the Eastern Section YPs have been busier than ever. If you haven't had an opportunity to check out our events, here is a recap of some of the recent activities:

- The Eastern Section YPs hosted a meet and greet in September following the first day of technical sessions at our annual meeting in Lexington, Ky. More than 50 AAPG Members attended, making it the most well attended gathering the Eastern Section YPs have hosted since our inception.
- YP Travel Grants: Thanks to the generous funding by AAPG to help support YP growth and development, the Eastern Section YP Committee was able to provide six Eastern Section YPs with two nights of accommodations at the section meeting in Lexington.

The author (center) mixing with other YPs at the recent "Pass the Baton" event in Pittsburgh.

Event Spotlight

The successful panel discussion event co-hosted with the Division of Professional Affairs (DPA), "Pass the Baton: Mentoring, Networking and your Career" was held May 8 in Pittsburgh. The panel was comprised of one moderator and a diverse group of five experienced professionals who engaged in an informative and invigorating discussion, sharing their personal experiences and advice with two dozen Eastern Section YPs. The event was held in a private dining room, creating a distraction-free space where everyone was able to speak candidly and interact comfortably with the panel members.

Panel members openly shared stories about their career as geoscientists, discussing not only the successes, but also the failures they experienced along the way. They made many helpful suggestions to the audience, advising early career geoscientists on ways they can be proactive during this challenging time. The YP and DPA organizers informed the audience of the multitude of resources that exist within our organization for those who have lost their job and are experiencing a career transition.

The event was a great success, achieving a handful of important objectives the organizers set out to attain. Thanks to a diverse panel, including geologists from many different niches within our industry, audience members were able to gain an understanding of how each panel member weathered the storm of previous industry downturns.

Getting Involved

If the panel discussion sounds like an event you would have liked to attend, fear not! The entire discussion was video recorded and is located on the Young Professionals page of the Eastern Section

See **Involved**, page 32

AAPG Foundation Helps Scouts Discover Geology

By KELSY TAYLOR, EXPLORER News Editor

The Boy Scouts are asking AAPG Members to volunteer for the National Scout Jamboree, a special event held once every four years for Scouts across the nation and around the globe.

Set for next July, the event will welcome more than 35,000 Scouts to a beautiful setting in Beckley, W. Va. that will be filled with adventurous activities for everyone to enjoy.

Those activities include whitewater rafting, kayaking, rock-climbing, bouldering and mountain biking. Scouts will also have the opportunity to learn outdoor skills, get to know one another, see new technology in action and earn merit badges.

There are 130 different merit badges that can be earned in the Boy Scouts, about 70 of which will be available during the event. This is an important opportunity for Scouts with limited access to so many badge opportunities, due to their location.

One of the badges will be the Geology Merit Badge, noted Ron Hart, coordinator for the badge.

He explained that the AAPG Foundation has been a great support for the badge since the 1930s by maintaining the requirements and description of the badge. In fact, the AAPG Youth Education Activities Committee used to be called the "AAPG Boy Scout Committee."

Beginning in 1993, the Foundation has helped support a team of geologists, mostly made up of AAPG Members, in attending the Jamboree to teach the badge.

A volunteer teaches Boy Scouts about geology during a National Scout Jamboree. Courtesy of the Boy Scouts of America.

"The AAPG Foundation has generously funded the teaching team once again with a gift from the E.F. Reid Scouting Fund. E.F. 'Bud' Reid was a president of AAPG in the early 1980s and was active as a volunteer and philanthropist in the World Scouting Organization. His vision created the E.F. Reid Scouting Fund so there would be a long-term endowment to support teaching geology to Scout groups," said Hart.

He added, "The AAPG Foundation sees value to putting a positive message about careers in geology, and specifically petroleum, in front of 35,000 Scouts and their families. Also, we want to meet the best and brightest kids and expose them to geology as a career."

Earning the Badge

To earn the badge, Hart explained, "A Scout must learn and understand principles of geology, and must complete several activities showing what he has learned."

During the Jamboree, Hart said that Scouts learn the process of the scientific method. They will be asked to either organize and describe a collection of 25 rocks and minerals and understand the economic uses of each, or learn to construct a stream model by taking field measurements around the property to create stream gradients, valley profiles, etc.

"In learning field work, a Scout must learn to note important observations and check his map location using GPS or other technology."

The merit badge program is designed to introduce Scouts and their families to hobbies and career options.

"Most of these Scouts are only exposed to earth science through middle school teachers and never have the chance to visit with a professional geologist. We all know the oil industry has the coolest toys and offers an exciting career, and we need to share that information with the next generation," said Hart.

Of all the badges in the program, the Geology Merit Badge ranks 28 out of

Continued on next page

Continued from previous page

135 in popularity and more than 22,000 Scouts sought to earn it last year.

"This is a tremendous opportunity for us to educate these Scouts and their families about the science we use to find oil, and we have a chance to debunk the many myths and junk science that surrounds the petroleum industry as seen by politicians and the media," Hart added.

Volunteers Needed

The badge wouldn't be possible without the help of volunteers to teach geology to the Scouts. AAPG Members continue to be heavily involved with the badge and it is hoped that more Members will volunteer for the upcoming Jamboree.

"During the day, team members will either teach a rock identification class or take a small group on a short hike to study erosion and steam patterns," he said. "We work from a duty roster that guarantees we have full staffing at peak times, but all team members are given time away from the merit badge tent to fully experience the Jamboree activities."

Hart noted that the event is very rewarding for everyone who volunteers.

"Talking to kids about geology helps me focus on my own career and life accomplishments. Too many times we work on the same tasks every day in an office and forget why we got into geology in the first place," he said.

"I love to watch the light come on. Most Scouts are not interested in a geology career, but it seems every group has one or two who begin to look at science (and geology) in a new way. We want to meet that Scout. By nature, Scouts love the outdoors and it's natural for them to become interested in geology," he added.

Volunteering begins by registering with the Boy Scouts of America as a merit badge counselor. The only requirement is that the volunteer is a U.S. citizen and is excited to help the Scouts.

For more information about volunteering, contact Hart at ron_hart@cox.net. To discover more about the event, visit www.summitbsa.org.

Ron Hart is the Jamboree Geology Merit Badge Coordinator for the Boy Scouts.

Foundation Contributions for September 2016

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Daniel Burton
Dean L. Callender
John R. Carson
Chevron Matching Employee Fund
Matching gifts given by George Pritchard
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In honor and memory of all who have helped me along the way
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William M. Whiting
In memory of great, great, great grandfather Jonas Whiting (1755), Quartermaster Sergeant, Massachusetts Militia, Revolutionary War
In memory of great, great, great Uncle Samuel Whiting (1752), Massachusetts Militia, Revolutionary War
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L. Austin Weeks Undergraduate Fund
Robert D. Williams

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

CLASSIFIED ADS

You can reach about 37,000 petroleum geologists at the lowest per-reader cost in the world with a classified ad in the EXPLORER. Ads are at the rate of $2.90 per word, minimum charge of $60. And, for an additional $50, your ad can appear on the classified section on the AAPG website. Your ad can reach more people than ever before. Just write out your ad and send it to us. We will call you with the word count and cost. You can then arrange prepayment. Ads received by the first of the month will appear in the subsequent edition.

CLASSIFIED ADS

MISCELLANEOUS

SAMPLES TO RENT

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Established in 1947. Have 164,000 wells with 1,183,000,000 well samples and cores stored in 17 buildings from 26 states, Mexico, Canada and offshore Australia. We also have a geological supply inventory.

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Stoner Engineering LLC

* *

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Beautiful handmade globes for gifts, office or lab. See explanatory notes online at www.realworldglobes.com

Involved
from page 29

website at ESAAPG.org for all to view.

Want to be a part of the Eastern Section YP community? If you are interested in learning more about Eastern Section YP events (past and future), or would like to contact the Eastern Section YP liaison, you can also find contact information and an up-to-date calendar of events and highlights on the Eastern Section website.

If you're interested in volunteering with the AAPG YP Special Interest Group, or just want to learn more about YP initiatives in your area, visit us online at aapg.org/youngpros and contact your Region or Section YP coordinator. You can also 'like' us on the AAPG Young Professionals Special Interest Group Facebook page and follow us on Twitter and Instagram @aapgypsig.

Emissons
from page 28

Meeting that showed that "despite active natural gas extraction in Denver, at least 50 percent of methane emissions in these regions are from agricultural and/or landfill sources. Previous studies had attributed most or all emissions of methane to natural gas production." Townsend-Small also reported on a study where pre-drill water samples showed that biogenic methane is the primary component of dissolved methane in groundwater wells in the Utica Shale area.

* * *

Even as disagreements about the sources and amounts of fugitive methane continue, oil and gas operators have to monitor their facilities and repair leaks based on rules in several states. In addition, the Environmental Protection Agency (EPA) now requires monitoring and leak repair at new oil and gas facilities including wells, compressors, pumps and transmission lines.

Starting in October, EPA began to collect large volumes of information about oil and gas industry operations, facilities and emissions to help them formulate rules for fugitive methane monitoring and mitigation from existing facilities.

Changes to AAPG's Communication

Throughout the year, AAPG sends emails to everyone involved in the Association. The emails share information about upcoming events, educational opportunities, how to participate in new publications, membership news and more.

Laws have recently been put into place worldwide that require AAPG to only send emails to recipients who have specifically stated they would like to receive them.

AAPG is working to create email lists that are in full compliance with these laws no later than June 30 of next year.

The Association staff is encouraging Members who would like to continue receiving emails to visit and log in to www.aapg.org. Once logged in, click "My Profile" and then click "Contact Preferences." Then indicate the types of emails you would like to receive.

The accompanying QR code will lead you to a login screen and then directly to your contact preferences.

Once completed, you will receive two emails. The first will list the details of your changed preferences. The second will include a link to follow that will confirm your email address.

At the bottom of each email sent from AAPG is a link to update preferences or unsubscribe. If you unsubscribe, you will only receive communication from AAPG about membership and transactions.

AAPG will be posting a survey soon to gather input about what recipients would like to see and what they need in our email communications.

PROFESSIONALnewsBRIEFS

A Lifetime of Service


BROADHEAD

Ron Broadhead was recently honored for a lifetime of service to the oil and gas industry by the New Mexico Oil and Gas Association. He is the head of the Association's oil and gas program and also serves as a senior petroleum geologist at the New Mexico Bureau of Geology and Mineral Resources.

As a Member of AAPG, he has been the editor of Search and Discovery since 2011. He has also been a past recipient of the Distinguished Service Award, the A.I. Levorsen Memorial Award and the Long Service Award from the AAPG House of Delegates.

Susan Howes, to vice president of engineering, Subsurface Consultants & Associates LLC, Houston, Texas. Previously reservoir management consultant/talent management expert/ global industry leader, Chevron, Houston, Texas.

Daniel Doolittle, to principal scientist, Inspire Environmental, Newport, R.I. Previously exploration manager-geoconsulting, Fugro, Houston, Texas.

AAPG and SPE Head to Kenya

The inaugural Africa Energy and Technology Conference, presented by AAPG and the Society of Petroleum Engineers, will be held Dec. 5-7 in Nairobi City, Kenya.

Two training courses have been planned. The first will be "Improving Success in Drilling." The course will share information about the best ways to develop a drilling plan and budget. It will also cover the management of operational problems that are common in Africa.

The second is titled "Petroleum Geology Fundamentals" and will introduce the basics of petroleum geology.

Technical sessions will be held throughout the conference that will share examples of geoscience, engineering and energy projects across Africa along with a wide range of topics.

Three panel sessions have been created that will discuss "Africa in the 21st Century: Frontier Plays and Challenges," "Smart Goals for a Sustainable Future" and "Petroleum Regulation and Contract Sanctity."

During the event, posters will be displayed and an exhibition area will serve as an ideal spot for networking with companies and other attendees.

A field trip will conclude the conference, taking participants to the Kenya Rift Valley, one of the best-exposed continental rift systems in the world.

For more information, visit the SPE website at SPE.org.

INMEMORY

Eugene Carter, 62
Lakeway, Texas, Dec. 6, 2015
Louis Dixon, 101
Baton Rouge, La., Aug. 19, 2014
Allen Kelley, 59
Houston, Texas, March 29, 2016
Alan Talley
Federal Way, Wash., Jan. 1, 1954
James Anderson, 91
Norman, Okla., May 26, 2016
Ross Brunetti, 63
Orcutt, Calif., Aug. 12, 2016
Earl Harrison, 93
Abilene, Texas, Sept. 15, 2016

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

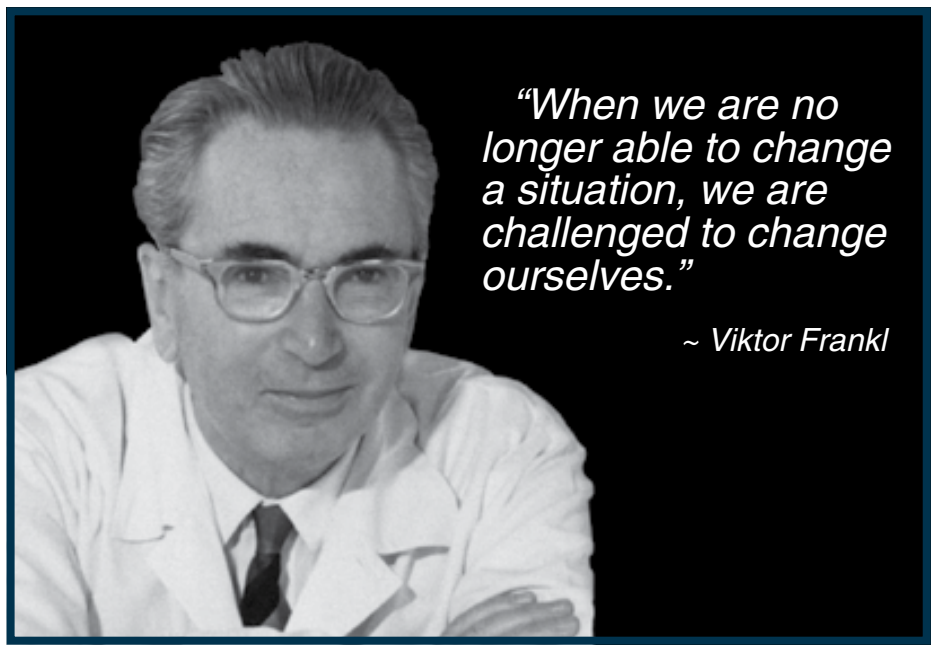
DIRECTOR'S CORNER

Gratitude: A Virtue and a Discipline

By DAVID CURTISS


CURTISS

When everything is seemingly falling apart, it's easy to get caught in a downward spiral of discontent that leads to despair.



Here in the United States we celebrate Thanksgiving on the fourth Thursday in November.

All across the country families and friends gather together around tables filled with roast turkey, stuffing, mashed potatoes, cranberry sauce and green bean casserole. American football – either watched on television, or played in the backyard – is another staple, as is laughter, feelings of togetherness, and even the occasional argument.

But too often, the planning of the event and all the preparation leading up to it causes us to lose sight of what Thanksgiving is all about: gratitude.

I don't know about you, but gratitude is something I've struggled with in 2016.

It isn't that I've deliberately planned to be ungrateful. But, as the U.S. presidential election exposes deep societal fissures in this country, political decisions around the globe heighten tensions and the industry downturn affects so many of our Members, it's very easy to lose sight of what's going well. The bad news drowns out the good.

"When we are no longer able to change a situation, we are challenged to change ourselves," wrote Viktor Frankl, neurologist, psychiatrist and Holocaust survivor, in his 1946 memoir "Man's Search for Meaning."

When everything is seemingly falling apart, it's easy to get caught in a downward spiral of discontent that leads to despair. Yet, as Frankl points out, it's up to us to do the hard work of changing, and this month I am working personally to cultivate a deeper sense of gratitude.

I don't believe gratitude is mystical or magical; I'm not trying to create a religion out of gratitude. But I do believe that a practice of identifying the people, things and experiences in our lives for which we can be thankful can help us deal with life's adversities, because it forces us to get out of our own heads – to stop being so self-centered.

Training in Gratitude

This doesn't happen on its own. It takes practice. So each day this month my goal is to identify three things that I am thankful for. Perhaps it's a simple thing, like a beautiful autumn day, a smile from a loved one, or a personal or professional accomplishment.

But this exercise shouldn't be too simple. This is practice, after all, and I'm training my gratitude muscle. So, I am also looking at the failures in my life, at the hard times, the tragedies.

Can I be thankful for these experiences? Is that even possible? And what about the difficult people in my life? Is there a way to be thankful for them, too?

I'm feeling a bit anxious even as I type this. This exercise is going to make my head hurt, but I also expect it to change my outlook and perspective.

You may or may not celebrate Thanksgiving, but will you consider joining me this month in practicing a spirit of gratitude?

As you spend time with family and friends – with your community – sharing, laughing, crying; as you confront life's joys and its disappointments; as you read the news and reflect on the many challenges we face on this planet, look for those things to be thankful for – especially the hard things.

My sense is that if we were able to give thanks in all circumstances, the world would be a markedly different place.

DIVISIONS REPORT: EMD

Are You a Convention-goer?

By ANNE DRAUCKER, EMD President


DRAUCKER

I think conventions offer something for everyone. I think low price environments are the perfect time to go to a convention.

It's convention time!

No, really. It is.

First of all, it's always convention time for AAPG. Sections and Regions have meetings throughout the year. AAPG also runs numerous workshops, seminars, classes and symposiums. The AAPG event staff have put on four major conventions in the last five months, which is amazing.

I mentioned in my last article that the Energy Minerals Division (EMD) participates in conventions by sponsoring sessions, field trips and short courses. With the centennial of AAPG in 2017, the upcoming Annual Convention and Exhibition (ACE) and International Conference and Exhibition (ICE) are going to be packed full of activities.

The call for papers for ACE has already gone out and been closed. Abstracts are submitted, themes are selected and the program will be announced in January. I've been reading the themes and I'm excited to hear all the new things happening in a variety of topics. Planning for 2018 is also under way and I've already heard several amazing ideas for field trips. I have no doubt that both the Houston Centennial meeting and the 2018 meeting in Salt Lake City will be excellent.

Taking the Good with the "Bad"

Conventions are one of my favorite things. I love almost everything about them: technical content from areas in which I work, technical content in areas I have nothing to do with and know nothing about, exploring the exhibition floor for new products, contacts and souvenirs and seeing all my friends (we're supposed to call that "networking").

The only aspect I don't love is the accumulated sleep deprivation. That's my own fault. I find the atmosphere at conferences to be highly intellectually stimulating and my FOMO kicks into high gear. (For the non-millennials, "FOMO" is "Fear Of Missing Out.")

I get up early-ish to attend talks then stay up way too late talking to folks I haven't seen in a while or with whom I'm working on AAPG projects. Sitting in those convention lobby bars, I learn about the rich history of the Association and generate ideas for the future. Regardless of company support or how full my calendar is, I always plan to go to ACE, because the benefits for me always outweigh the time, money and personal energy spent.

Gathering Perspectives

But, as many superlatives as I can apply to conventions, I've heard from various folks that either conventions aren't their thing, or they like them but don't go because oil prices are down.

I don't get that, because it's not my experience. I think conventions offer something for everyone. I think low price environments are the perfect time to go to a convention. You make contacts that can lead to a new job, you gain skills you didn't previously have, you get to talk about rocks and fossils and Mars and go home with a full brain sparking with new ideas and revitalized enthusiasm.

But that's *me*.

Others have different reasons for going or not going. I've been trying to gather different perspectives lately, and I've heard fascinating stuff from AAPG leaders of all ages and experience levels – reasons for going or not going that have never occurred to me.

So here's what I want to hear from you: Why do you go (or not go) to conventions? Do you prefer the big conferences like ACE or the smaller Section meetings? Do you draw a distinction between business (how you ask for funding from your supervisor) versus personal (travel, friends, breweries) reasons? What kinds of talks do you attend once you're there (subjects you work in, subjects you don't know anything about, geology hobbies)? If you want to go, but can't, what are the barriers?

Shoot me an email (you'll have to go to the EMD website to get my email address. See what I did there?), let me know your thoughts and opinions. Visit www.aapg.org/divisions/emd.