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EXPLORER

Ocean of Opportunity

Offshore Arctic exploration heats up.

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PRESIDENT'SCOLUMN

Now, On To the Next Century

BY PAUL BRITT

Now that the ACE Centennial Celebration in Houston is behind us, I just have to congratulate some of the many committees, Members and staff who contributed to its success. With around 7,800 total attendees, it came close to projections. More importantly, I cannot adequately describe the number of Members who approached me with kudos and congratulations on AAPG hosting such a remarkable event. The truth is, without the aforementioned people, it would not have been possible.

At the Gala, the 100th Anniversary Committee and the General Convention Committee were rightly credited for their efforts, and they certainly had tremendous influence on the event's success.

Highlights from ACE

But perhaps less recognized in the presentations were the efforts behind some of the other events by other committees and special interest groups.

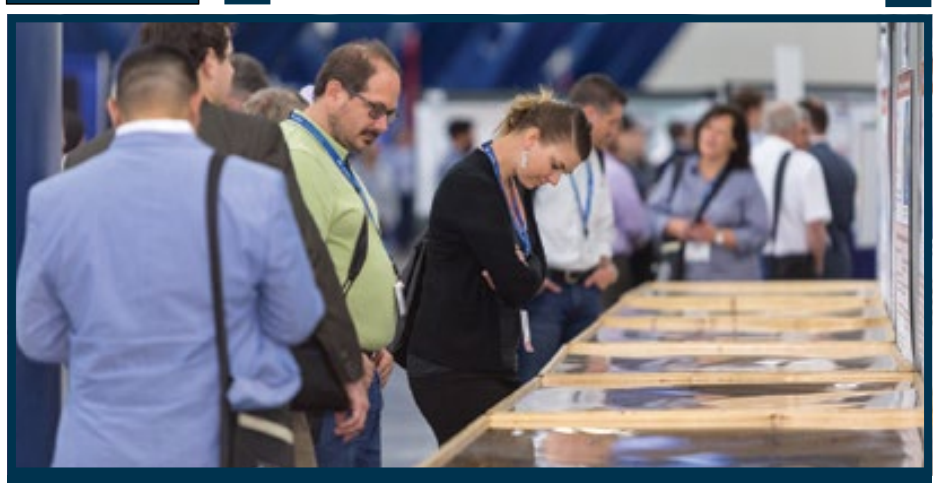
First, on the Saturday preceding ACE was the day-long PROWESS/AWG/SEG Forum: "Pioneering Women in Petroleum Geology: 100 Years," which included the world premiere of a new documentary funded by the AAPG Foundation: "Rock Stars: Pioneering Women in Petroleum Geology." (See page 24 for full coverage.)

On Sunday, the History of Petroleum Geology Committee held its forum as a special session commemorating the centennial with a series of papers, which ran the gamut from the scientific foundations of petroleum geology before the founding of the AAPG through the development of technologies and discoveries throughout our first century.

Throughout the week, the convention featured displays and presentations on the First 100 Women Members in AAPG, the Preservation of Geoscience Data Committee's display of cores from the many and varied reservoir types representing some of the major oil and gas discoveries over the last 70 years, along with a range of data and media taken from the last 100 years of oil and gas exploration.


BRITT

> Even if oil jumped in price, it appears that business trends will continue to change rather than returning to the previous status quo.


The Preservation of Geoscience Data Committee displayed cores and data from the last 100 years.

On Tuesday the Division of Professional Affairs luncheon featured a talk by the legendary Wallace Pratt, portrayed by an actor, which made for a remarkable performance. Also on Tuesday, the Division of Environmental Geosciences and the Energy Minerals Division began a two-day, joint forum on "The Next 100 Years of Global Energy Use," which featured a look forward to the upcoming challenges the industry faces.

On Wednesday, a special session on major deepwater fields in the Gulf of Mexico balanced out the robust technical sessions. And of course, there were all the usual featured sessions, luncheons and forums that make up the ACE.

I just want to issue a special thanks to all of these Members and committees, as well as acknowledge the support by the Houston Geological Society in making ACE a successful event – especially in an otherwise problematic year for events in general. And, of course, thanks to the AAPG staff who worked tirelessly to make it all come together.

Strategic Plan

Now we embark on the next century.

As I mentioned in last month's column, the Advisory Council has prepared a new long-range/strategic plan for going forward.

Based on the assumption of oil remaining in the $50 price range for the foreseeable future, the plan includes a careful analysis of the demographic trends of membership, a forced ranking of AAPG products and services, recommendations on modifying or cutting many of AAPG's programs, such as online education, CD/DVD sales and other programs and associated committees.

Some of these have been implemented, and more will be before the end of the fiscal year. This will include a focus on the cost of governance, such as reducing face-to-face meetings and associated travel with more virtual meetings.

Many changes will be necessary to reduce the cost of operations for AAPG. Other discussions will include increasing revenue, though those changes will likely require more time.

In all, this year is a pivotal year for the AAPG, in order to make it more nimble and adaptable to a rapidly changing business and social environment.

One item of note: even if oil jumped in price, it appears that business trends will continue to change rather than returning to the previous status quo.

The ultimate goal is for the AAPG to continue to be the "go to" association for petroleum geoscience, regardless of market conditions and budgeting constraints.

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REGULARDEPARTMENTS

ON THE COVER:

This mosaic of images of the Arctic was taken from the Moderate Resolution Imaging Spectroradiometer on NASA's Terra satellite. After the massive discovery offshore Alaska's North Slope last year and recent recommendations by the National Petroleum Council, among other developments, the Arctic Circle is a fast becoming a hotspot for offshore exploration.

Left: The exhibition floor was a constant bustle of activity at this year's centennial ACE. For highlights, see page 22.

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Geophysical Paradigm Shift Stalled By Lagging Software

By KEN MILAM, EXPLORER Correspondent

Changes in technology and ways of thinking have taken the industry places hard to imagine just scant decades ago.

In the area of geophysical exploration, new ideas and techniques continue to evolve.

Where will they take us?

Two experts in the field, Andy Williamson, founder of New Wave Exploration, and Paul MacKay, president and CEO of Shale Petroleum Ltd., both located in Calgary, Canada, offered their take on what future decades might look like for geophysicists.

Both agree that geophysics will continue to play a pivotal a role in the world's energy future.

"The quality of interpretation and the ability to integrate geologically sound principals into the seismic data is still the most important step. This means that geophysicists should be geologists first. It seems obvious that if looking at seismic to give a geologic interpretation the interpreter should understand geological principles, but that is not always the case," MacKay said.

"Interpretation software development has stalled over the last decade. We're ready for a paradigm shift in the way we work with data. There have been some interesting enhancements in visualization that were catalyzed with the increased use of microseismic data, and there is now much more power on the desktop for true 3-D seismic interpretation. In retrospect, the pace of this development is disappointing," Williamson said.

Men and Machines

In the near term, many experienced geoscientists will retire, but Williamson and MacKay say new people will step up to fill the gap.

"The supply of a trained work force will balance the demand," said Williamson. "The bigger question is, what will the demand for geophysical interpretation be into the next decade? I do expect that less experienced professionals will face steep learning curves and many technical challenges before they're completely ready, but I have no doubt that the work will get done."

"The crisis in qualified workforce will not be restricted to only geophysics. It is simply the nature of a commodity-based business. We saw the same thing in the 1980s and the late 1990s. I don't really see it as a problem to be solved; the market forces will address it," MacKay offered.

Artificial intelligence is seen by some as a threatened replacement for the human element, but MacKay and Williamson see it as another tool for experienced interpreters.

"Geophysics has always been a leader in technology, especially advances in computer technology. Artificial intelligence will be used, as well as learning programs, for instant turn around on acquisition to interpreted data volumes. This will not put geophysics out of business but will make geophysics more important. One of the great advances in geophysics has been 4-D acquisition and microseismic These technologies are directed to better production practices; this will become a more important process in the future as we begin to unravel the complexities of the reservoir, "MacKay said.

"We've seen neural networks play a significant part of data analysis, but these do not replace interpreters. I think this will continue, and maybe we'll see artificial intelligence implemented in ways we cannot even think of now. But I think geophysicists will still need to condition the data and the inputs and evaluate the results," Williamson said.

Independents and Innovation

Some of the super major oil companies that have existed over the last 100 years have their internal R&D groups, but lately have left it to the smaller companies to generate new technology ideas.

Williamson said that in the late 1990s, research and development began to shift from major oil companies to larger service companies.

MacKay sees the trend continuing.

"The majors developed the R&D groups as a competitive advantage. With the growing use of Big Data, analytics and new data sources, the institutional approach of directing research is antiquated. I don't see how large companies with their onerous overhead and need to justify quarterly returns on capital will be able to keep up with small groups that are prepared to work out of humble settings and direct themselves. Many of these groups may fail but the ones that succeed will do so faster, with greater returns, than cumbersome institutions. I think we have gone through the shift where small research groups are more efficient, more productive and develop a better product," he said.

Lagging Software

Could any new technology supplant the seismic method?

"The seismic method has been the benchmark in oil and gas exploration. We have seen the emergence of new technology, such as airborne stress field detection, met with significant speculation and intense review of the underlying science. The purveyors of new technologies are forced to document believable case histories and compare their results to

See **Risk**, page 11

Offshore Exploration a Bright Spot for Latin America E&P

By EMILY SMITH LLINÁS, EXPLORER Correspondent

Offshore opportunities from Aruba to the Falkand Islands have national and independent companies keeping their eye on Latin America.

Current opportunities and future exploration potential were common themes in the Latin America and Caribbean Region Session held at the Annual Conference and Exhibition (ACE) in Houston last month.

The session, led by Victor Vega of Shell and Ulises Hernandez of PEMEX included an overview of the past, present and future activity in eight countries.

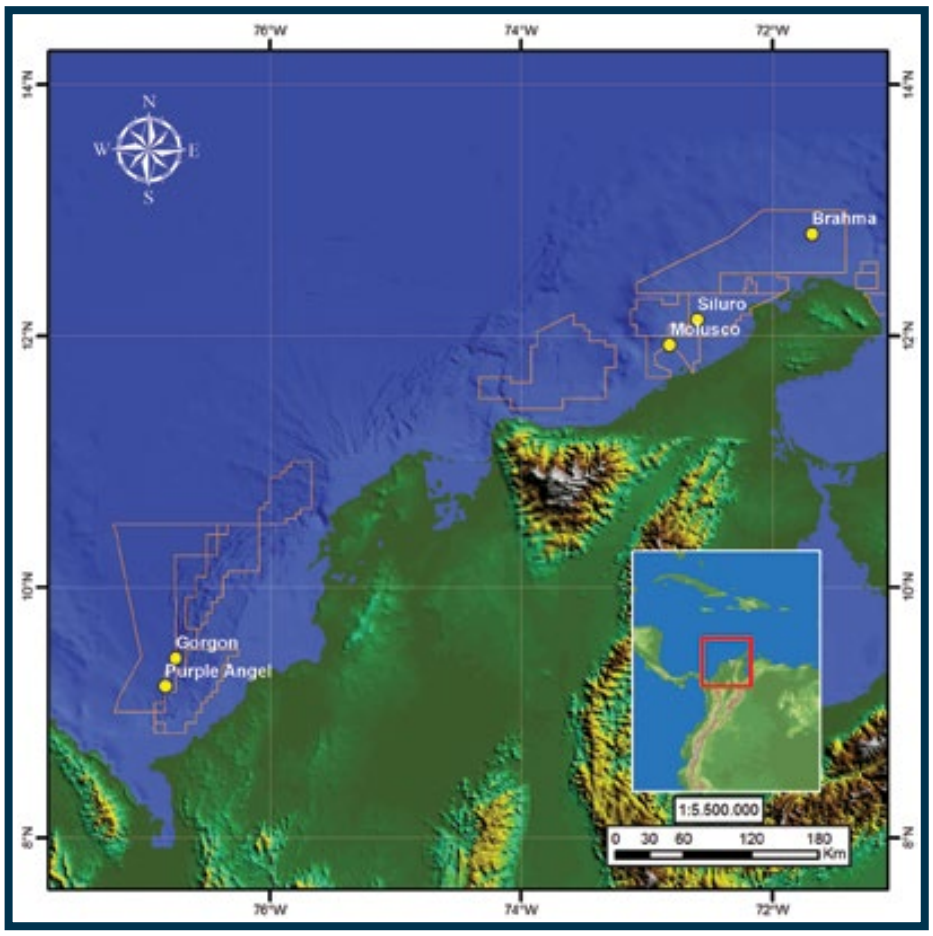
"The Region has enormous potential, both onshore and offshore, in conventional and unconventional resources," said Victor Vega, current president of AAPG's Latin America and Caribbean Region.

Exploration Trends

Carlos Macellari, director of exploration and development at Tecpetrol, provided an overview of exploration trends in Latin America.

He noted that the largest fields discovered during the last 10 years in Latin America were found in the deep offshore, with more than 77 BBOE added and average field sizes of 550 MMBOE. Most of the discoveries so far are located in the pre-salt of the Campos and Santos Basins in Brazil.

Macellari noted that recent discoveries in offshore Guyana show that many of the Atlantic basins remain poorly explored and hold important potential. Other areas of focus in coming years include the deep offshore Caribbean basins of Colombia and Mexico.



Colombia: A New Hydrocarbon Province

Jorge Calvache, offshore exploration manager at Ecopetrol, described the Colombian national oil company's transition from an onshore heavy oil company to an offshore company focusing on gas.

He shared Ecopetrol's plans to participate in operations of five wells in the Colombian Caribbean during 2017.

With more than 100,000 kilometers of 3-D seismic data obtained in the deep and ultra-deep water, Ecopetrol and other partners see enormous potential in the region.

He highlighted recent discoveries, including Orca 1 (operated by Petrobras), drilled in the Tayrona block in 2014.

Kronos 1 (operated by Anadarko), in the Fuerte Sur block, drilled in 2015 found gas in a sandstone reservoir. Purple Angel 1, drilled to the northeast in February 2017, confirmed the continuity of the field.

Upcoming projects include Gorgon 1 (operated by Anadarko), also located in the Purple Angel block, and Molusco, in the RC 9 block, the first well to be operated by Ecopetrol.

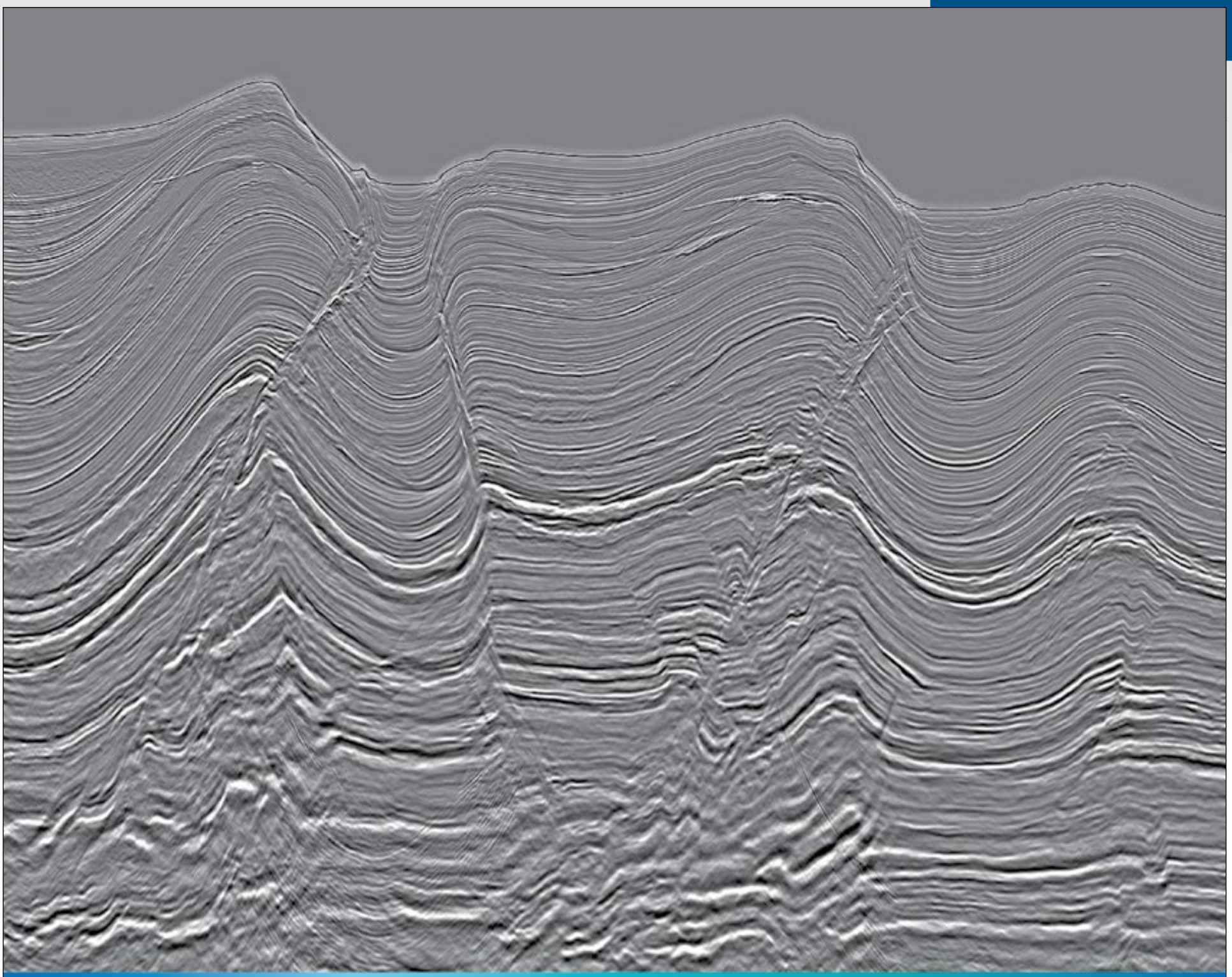
"We know that we are learning to operate in the offshore, so the knowledge and experience of our partners is very valuable," Calvache said.

While Magdalena Delta traditionally has been recognized as a biogenic gas province, Calvache said future exploration might prove differently. He described how piston coring and high resolution geochemistry have provided evidence both of a biogenic gas system and an active thermogenic system, potentially tied to Mesozoic-oil prone source rocks.

Offshore Colombia has an unranked potential of 35-87 TCFG of gas, providing great opportunities for Colombia and for the region, Calvache explained.

Production is declining in the country's primary gas source, the Chuchupa-Ballena fields discovered in the 1970s by Texaco (now Chevron), resulting in a gas deficit in

See **Caribbean**, page 8



Caribbean

from page 6

Colombia. At the same time, neighbors like Ecuador, Panama, Jamaica, Aruba and the Dominican Republic, need more gas.

"Ecopetrol would like to commercialize gas to meet this demand," Calvache said.

Currently Ecopetrol operates one block, RC9, located in the shallow waters off the Guajira peninsula, North of the Chuchupa-Ballena field. The company hopes to become a more active operator in the future.

Western Caribbean: Perla and Beyond

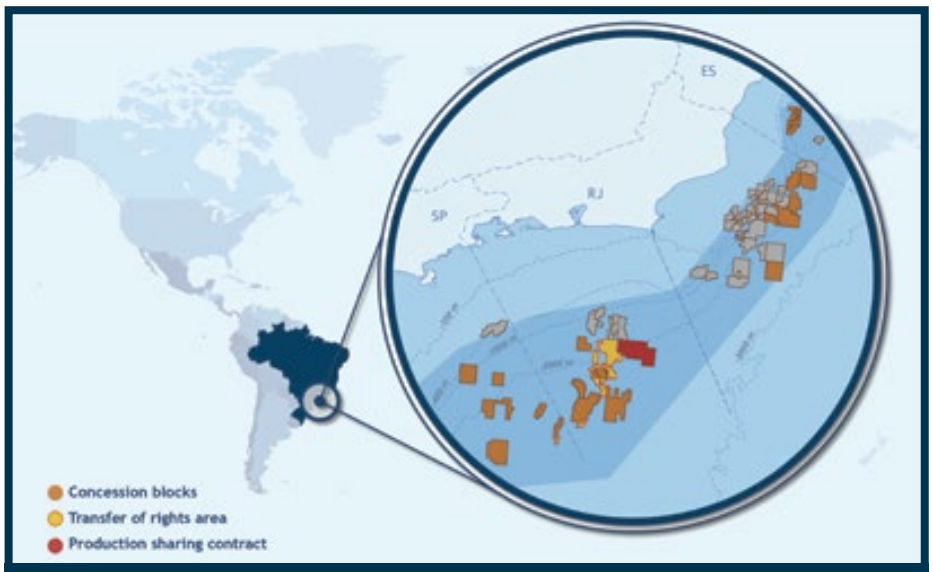
Mikel Erquiaga, global new ventures director at Repsol Exploración SA, provided a 50-year overview of hydrocarbon exploration in the Western Caribbean offshore basins and shared next steps Repsol and ENI have following the Perla field discovery in 2009.

Erquiaga noted that the most intense exploratory activity took place in shallow waters in the 1960s and 70s, with the first exploratory wells drilled in the Nicaraguan Rise in Nicaragua and Honduras and in Colombia's Guajira peninsula.

This first regional exploratory stage targeted primarily Eocene-Miocene carbonate banks/build-ups above basement structural highs with little success. From the 1980s onward, exploration activities nearly ceased in the Western Caribbean, which was believed to be a biogenic gas province.

That all changed in 2009, with the discovery of thermogenic gas and condensate by Perla-1 well in the Gulf of Venezuela. Erquiaga described Perla as a "paradigm breaker."

The discovery of Perla gas field, with 15 TCF of reserves in a lower-middle Miocene carbonate build-up, proved for the first time, the existence of a thermogenic petroleum system in the western Caribbean.



As known, the Brazilian pre-salt was discovered in 2006 and covers an area of 149,000 square kilometers.

Since then, Repsol's and other companies' exploration campaigns have focused on identifying additional thermogenic hydrocarbons.

After Perla, Repsol started obtaining more acreage and the company now has assets from Trinidad to offshore Colombia. The company moved to the Nicaraguan rise and drilled Paraiso, which did not have positive results. Erquiaga noted that the source rock is very immature in Nicaragua, and when the company realized they would not find large accumulations of oil, they chose not to continue further.

Plans for 2017 include drilling Siluro, located in offshore Colombia and future activity in Aruba in the Curacao trough. The company also is working with Petrobras, Ecopetrol and Statoil to drill wells in the Orca discovery area in the Tayrona block.

Mexico: Opportunities for Partnerships

José Antonio Escalera , vice president of exploration for Petróleos Mexicanos (Pemex), and Ulises Hernández, Pemex's vice president of geosciences and technical assurance, shared how Mexico's energy reform offers unprecedented opportunities for exploration and development offshore.

"There are important prospective resources offshore Mexico, particularly in deep water," Hernández said, adding that implementing new concepts and new ideas will further increase the country's potential identified to-date.

Mexico's energy reform has brought changes to Pemex's operations and strategies, he said.

"The energy reform defined new principles to manage national energy resources. There are new institutions, new guidelines that led to new rules in Pemex," he said. "We now need to compete for resources."

Hernández shared Pemex's short and long-term objectives: strengthen portfolio, maximize value capture; seek competitive positioning, share risk and establish partnerships.

To make the most of the areas that it has retained, Pemex has focused investment on the most profitable areas, maintaining reduced evaluation operations in areas that will provide reserves to sustain production in the medium- and long-term.

Hernández noted that Pemex designed a farm-out strategy to optimize value capture by resource type.

Farm-outs in deep water and areas with unconventional plays will allow Pemex access to technology, international best practices and share technical and financial risks.

Though he did not discuss specific projects, Hernández noted that 2017 will bring exciting news for companies interested in partnering with Pemex.

"Pemex will be farming out very interesting exploration and exploitation opportunities over the next months, ranging from deep water, shallow water, conventional onshore to unconventional resources," he said, "So keep an eye on Pemex's farm outs."

Peru: Moving Deeper in the Pacific Offshore

Federico Seminario, exploration manager at Pluspetrol Peru Corporation, explained

See **Talara**, page 13

Capital Expenditures: Now, Then, and the Century Ahead

By DAVID BROWN, EXPLORER Correspondent

You can think about the future of capital expenditures in the oil and gas industry by considering the recent past.

A first observation: The industry has bigger capex budgets and spends a lot more money when times are good than when prices fall and cash is scarce.

In 2016, oil and gas companies shelled out an estimated $400 billion in capital spending for upstream projects, according to Bank of America-Merrill Lynch. That's a significant amount, but a huge drop from the industry's 2014 capex total of around $700 billion.

Overall, the industry cut about $1 trillion from capital spending plans in the post-2014 downturn, most of the reduction affecting near-term outlays.

Adam Sieminski is James R. Schlesinger chair for energy and geopolitics at the Center for Strategic and International Studies in Washington, D.C. His previous job was administrator and head of the U.S. Energy Information Administration (EIA), a post he held for four and a half years.

Sieminski recalled reading through projections of future spending needs for various parts of the global oil and gas industry.

"If you add those up, you need something like $750 billion a year in investment," he said.

High Capital, By Nature

A second observation: The oil and gas industry requires an enormous amount of capital investment, and will continue to have high capital spending needs in the future.


RODGER

> "Although costs are drifting lower, most basins are still enduring a sustained pause in new investment."

One role of the oil economist is to remind geologists that technology and prices really do matter, Sieminski noted. The industry often gets squeezed for cash when prices fall, but a rebound eventually happens, sooner or later.

"Capital has always been available – it's not like it didn't get done. But it's very big numbers," he noted. "When prices go up, the capital moves. Some things happen because companies have their own internal cash generation. Exxon can fund a lot out of its cash flow."

Oil and gas companies are not much different from households or governments. When they have money, they spend it. When they don't have enough to spend, they borrow it.

Sieminski said he's confident banks will provide adequate funding for the industry as conditions improve and they see the chance for a favorable return.

"These (future capital expenditure) numbers are big, but I'm not alarmed," he said.

Renewables and Unconventionals

Two long-term shifts will affect the industry's capital spending pattern in the coming decades. First is the growth of spending on renewable energy sources. Renewables will shift future energy investment but not dominate it, according to Sieminski.

"There are some people who believe most of the marginal increase will be coming from renewables, but I'm not seeing that in the numbers I work with," he said.

In Tulsa last October, Sieminski presented the EIA's longer-term outlook to 2040. While renewables gained percentage share in the energy mix, crude oil and coal still accounted for well over half the future energy supply.

A third observation: Oil and gas aren't going away. They will be part of the energy picture for decades to come, even if crude and coal provide a smaller portion of overall energy production. But changes will dictate that a larger share of the energy supply is provided by renewable sources.

"Some of those can happen just for economic reasons. Hydro is a renewable resource and we've been building hydroelectric dams for a long time," he observed. "The capital and the operating costs of a new gas plant are better than a coal plant. Part of that is because you don't need as much air pollution equipment on a gas plant."

"We have consistently been moving toward cleaner and more convenient fuels. Now we're moving toward renewables, and the share of renewables will go up," Sieminski said.

The second shift reflects increased spending on unconventionals, a change already under way.

"Unconventional spend in the U.S. is booming, but elsewhere capital and balance sheet preservation remain priorities and as a result, most forms of upstream spend have a fairly muted outlook," said Angus Rodger, research director of Asia-Pacific upstream research in Singapore for industry consultancy group Wood Mackenzie.

As unconventionals draw more activity and capital funding, other sectors like conventional onshore and shallow-water offshore plays look set for a longer-term decline, he said.

"The level of spend in deepwater does appear relatively healthy in the near-term, staying steady at between $55 billion and $62 billion in the period 2017-20, or around a fifth of total conventional upstream spend," he said. "The overall outlook for deepwater is for costs to continue to drift lower, which will support

Continued on next page

Continued from previous page

long-term investment."

Rodger said that outlook is supported by Wood Mackenzie's forecast of major investments in the Gulf Of Mexico (Mad Dog Ph2, Appomattox, Shenandoah, North Platte, Anchor), sub-salt Brazil, Mozambique (Coral FLNG, Areas 1 and 4) and new projects in Guyana (Liza), Senegal (SNE) and Israel (Leviathan).

"Deepwater will also continue to be the primary source for world-class conventional discoveries --of our top 15 wildcat wells to watch in 2017, almost all are in over 400 meters of water. It is where the majority of the conventional volumes in recent years were discovered," he said.

"Alongside relatively flat investment in other conventional themes, this all keeps the upstream ship relatively steady and on an even keen until 2020," Rodger noted. "After that period, investment in deepwater, LNG and oil sands maintains some strength but in other more mature sectors, such as onshore and shallow-water conventionals, we begin to see a steep decline kick in."

Cost-cutting

A positive trend in this "muted outlook" is the industry's efforts at cost-cutting and operational efficiencies, Rodger said.

"We are just not seeing a return to the levels of spend we saw over the previous decade, both in terms of existing assets and sanctioning large new projects," he observed.

"That said, some of the resource themes that have been particularly unloved over the past two years – deepwater and Canadian oil sands in particular – have taken the necessary steps over that time to reduce costs and be more competitive," he said.

Recent activity by BP in Egypt and Mauritania/Senegal, and Total and Statoil in Brazil, indicate a tentative but rising confidence in deepwater's future and show demand for high-quality deepwater assets that can move portfolios down the cost-curve, Rodger said.

"Nonetheless, it is not all good news for the deepwater industry. Overall, with less operators in the sector – following the exit of many independents – alongside longer-term capital constraints, we will see a deepwater sector that is smaller than in the past," Rodger predicted.

"Although costs are drifting lower, most basins are still enduring a sustained pause in new investment. The outlook for new FIDs is challenging, but reworked Gulf of Mexico fields that have slashed breakevens below $50/barrel is proof it can be done," he said.

The Coming Century

Looking outward to the rest of this century, you can expect the industry to have a continuing high need for capital investment. Oil and gas companies will approve bigger capex budgets in good times, smaller budgets when prices fall.

Renewables and unconventionals will soak up an increased share of investment, while the percentage share for conventional onshore and near-shore spending declines. Hydrocarbons will continue to meet a significant part of the world's energy needs.

And at some point, an advance will probably happen that turns everything upside-down.

"In the next 50 years, I'm pretty sure there will be some technological breakthroughs that change things," Sieminski noted.

"It would be nice to have cold fusion," he said. "But before we get there, we're going to have a big need for geologists."

Risk
from page 4

seismic data. The challenge for innovators is to find risk-takers who are willing to invest in testing new methods. That's a tough sell in a risk-adverse environment," Williamson said

"The issue in the short term is with commodity prices low, the industry has less patience for risk, including testing new technologies. In the future this may change but at this point in time the question is, 'Why look to make an affordable product more affordable?'" MacKay said.

"First it is incumbent on geophysicists to be aware of and knowledgeable about all the tools and types of data at their disposal for analyzing and mapping of the geology. At that point, the interpreter is limited only by their intuition, creativity, imagination, and what is fit for purpose for a particular problem or situation. Where it goes depends on the success gained by a certain technique, and the cost associated to deploy it. Historically, computing power has played a significant role in the universal availability and usage of many techniques, so I expect this trend will continue in the future," Williamson said.

"Interpretation software development has stalled over the last decade. We're ready for a paradigm shift in the way we work with data. There have been some interesting enhancements in visualization that were catalyzed with the increased use of microseismic data, and there is now much more power on the desktop for true 3-D seismic interpretation. In retrospect, the pace of this development is disappointing," he continued.

"Geophysicists should be able to see in 3-D as they interpret. The power of visualization software is to allow other members of the team to see it that may not have the same ability. So I see this tool as a communication tool, not an aid to interpretation," MacKay said.

Will the exploration projects of the year 2050 or 2075 will require different resources or skillsets?

"Emphatic 'yes' in the same way that our approach 50 years ago would be unacceptable today," MacKay said

"Without a doubt. Thirty years ago I would never have predicted what we do today. There's no way I can predict what our world will look like in 30 to 50 years," Williamson added.

The Case for Exploring the Arctic

By KEN MILAM, EXPLORER Correspondent

A National Petroleum Council report on U.S. Arctic oil and gas potential outlines a strong case for developing those resources.

And, recent massive discoveries offshore Alaska's North Slope by Repsol, Armstrong Oil and Gas and Caelus Energy have certainly validated that case, and then some.

The report, "Arctic Potential – Realizing the Promise of U.S. Arctic Oil and Gas Resources," was requested in recent years by the U.S. secretary of energy. It acknowledges environmental, cultural and other concerns. The comprehensive study involved more than 250 experts from industry, academia, government, native and environmental communities.

Four participants in the study recently discussed the findings in a panel discussion at the Arctic Technology Conference (ATC).

"Our NPC panel members bring a broad knowledge of this important piece of work," said Brian H. Miller, execution readiness manager, Alaska projects for SIEP and OTC board chair for the ATC. The speakers highlighted critical aspects of the study and answered questions.

Co-chaired by Mark Fesmire, Alaska region director, Bureau of Safety and Environmental Enforcement, and Mike Prins, senior adviser, Arctic, ExxonMobil Upstream Engineering Skill Center, the panel included:

- John Guy, deputy executive director, National Petroleum Council
- Mitch Winkler, Arctic senior technical advisor, Shell
- Tim Nedwed, oil spill response senior technical professional advisor, ExxonMobil
- Larry Hinzman, vice chancellor for research, University of Alaska Fairbanks

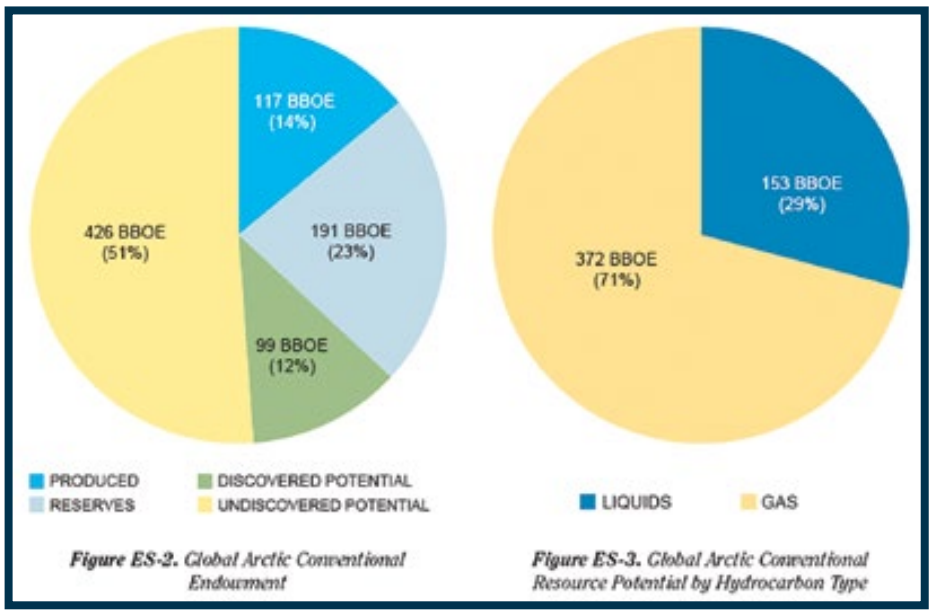


Figure ES-2. Global Arctic Conventional Endowment

Figure ES-3. Global Arctic Conventional Resource Potential by Hydrocarbon Type

The report said further "exploration and development in the U.S. Arctic would enhance national, economic, and energy security, benefit the people of the North and the U.S. as a whole, and position the U.S. to exercise global leadership."

Opportunity

It also acknowledged "diverse views on how to balance this opportunity with environmental stewardship," according to the report's executive summary.

In addition to oil and gas potential, interest is growing in Arctic tourism and reduction in summer ice offers more opportunity for marine traffic, the Council said.

In the global arena, the report noted that Russia is drilling new exploration wells in the Kara and Pechora seas and expanding its fleet. China does not hold any Arctic territory but is investing heavily in research, infrastructure and resource development in the region, the Council said.

The Council said the large U.S. Arctic oil and gas potential, much of it still undiscovered and offshore, could contribute mightily to meeting U.S. and global energy needs and the technology to develop it exists today.

Meanwhile, regulatory practices developed in non-Arctic regions are limiting activity in the Arctic, the report said.

Also, realizing the region's promise "requires public confidence that the opportunity can be safely pursued while ensuring environmental stewardship," the Council said.

The study recommended more research to validate current offshore technology and pursue improvements to enhance safety, environmental protections and cost performance.

Recommendations were grouped into three themes:

- Environmental stewardship
- Economic viability
- Government leadership and policy coordination

The Council noted that the current resurgence of production in the U.S. Lower 48 eventually will decline.

That is one reason given to pursue the Arctic now.

Alaskan exploration and development entails long lead times compared to other regions. If development starts now, production will contribute substantially to U.S. energy security in the 2030s and '40s, according to the report.

The study also notes the impact on the state of Alaska, which gets some 90 percent of its general revenue and one-third

Continued on next page

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of its jobs from oil and gas activities.

The report states: "Opportunities would be created throughout the state in both high paying, long-term, year-round jobs and in seasonal and short-term jobs. Of the 6,000 oil and gas sector jobs, about 3,900 could be long-term, year-round jobs. It is estimated that total national annual average employment from OCS development – including all the direct, indirect, and induced employment – could be about 35,000 per year on average through 2057, with a peak employment of over 50,000 in 2038. Total wages and salaries associated with OCS development over the 50-year period are estimated to be about $72 billion."

Environment

Environmentally, the Arctic is challenging, but fairly well understood after decades of experience.

Ice type and abundance, water depth and length of open water season are key factors.

Scientists have monitored important animal species in exploration and production areas for more than 30 years and found no long-term negative effects, the Council said.

They also said mitigation efforts to protect animal populations and subsistence hunting are working, but can be improved.

The ecological impacts of spills and other chemical releases are of concern and have been studied for years worldwide. The report found that there have been "substantial" technological and regulatory advances to reduce the possibility and consequences of spills.

Important developments in avoiding environmental impact include blowout preventers, capping stacks and subsea isolation devices.

"The risk of a spill can never be completely eliminated, so effective oil spill response capability is also critical," the report states.

Production

The industry has a long history of successful operations in Arctic conditions. Advances in the Arctic and elsewhere have allowed the industry to continue and expand operations while reducing environmental impacts, the report said.

Also, most of the conventional U.S. Arctic offshore potential can be tapped with field-proven technology.

Most of those resources are in less than 100 meters of water in areas where exploration is possible during summer and shoulder seasons with floating rigs. Development and production are possible with bottom-founded facilities and support vessels, methods already shown to be successful.

Operating is the Arctic is more expensive, however. Rugged climate, remoteness, lack of infrastructure and short operating seasons mean economic viability hinges on finding large, high-quality resources, the report said.

Regulation

Current regulations also hinder the economic viability of Arctic projects and should be updated and tailored to reflect the challenges of the region, the report recommended.

"An efficient regulatory framework with a clear process and a predictable timeline would support investment in challenging exploration activities. Two particular factors – drilling season length and lease length – currently have substantial negative implications for oil and gas exploration in the Alaska OCS," the report stated.

Because resources are larger, but spread less densely over wide areas than places like the Gulf of Mexico, more time and more exploratory wells are needed to lay the groundwork for development.

"In addition to extending the lease time available for exploration, holding more frequent and predictable lease sales would also improve the ability to plan and execute exploration programs, particularly important in an area with a short working season," the report said.

The Council also said both industry and government must engage local communities to gain and secure public confidence, which it called a key to realizing the promise of Arctic oil and gas resources.

Talara

from page 8

that Peru's 3,079 kilometers of shoreline have eight offshore basins, three of which have a proven petroleum system.

One of those basins is Talara, home to the second well drilled in America after the Drake discovery in Pennsylvania in 1859.

"Since 1863, Talara has been and is still producing oil and gas. We are sure that there are more opportunities to be discovered in the offshore of Peru," Seminario said.

Because Pluspetrol is not drilling offshore currently, representatives from Karoon and Gold Oil in Peru provided information on the offshore component of Seminario's presentation at ACE.

Talara has had a cumulative production of 1.6 BBO, with at least 20 percent of the total production from offshore. To date, all the offshore producing wells were drilled into the shallow water less than 380 feet of water depth. Middle and deepwater remains unexplored, but there are several prospects waiting to be drilled, including the Cuy prospect in Block Z34, a fourth way closure Anticline with a 3,800 meter drilling depth.

Cuy, expected to be drilled in 2018, will be operated by Gold Oil Peru (Baron Oil PLC) in partnership with Union Oil and Gas Group. According to data from Perupetro, 413 MMBO of unranked recoverable oil is anticipated.

The Tumbes Basin offshore is in early stage of production and remains a largely under-explored area with a high

See **Uruguay**, page 14

Uruguay

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prospective resource potential, Seminario said.

"New information coming recently from seismic, seabed drop cores, encourages the industry to extend exploration toward to mid and deep water in a wide variety of play types," he said.

Karoon mapped seventeen prospects in the Tumbes Basin, and has leads with multiple targets in block Z34. High quality 3-D seismic shows large untested structures with amplitude anomalies. Karoon, in partnership with Pitkin, plans to drill the Marina and Bonito prospects in 2018. The company projects volumetric of approximately 350MMb of oil in each prospect.

Seminario highlighted opportunities beyond Talara and Tumbes.

"The Sechura Basin proved a new play in fractured Paleozoic rocks. Some shallow water prospects have been mapped recently and are waiting for drilling. The other five basins are considered unexplored since only four wells have been drilled in the Trujillo Basin," he said

Uruguay: New Frontier in the South Atlantic

Oscar López-Gamundi, director of P1 Consultants, shared results from a study conducted by his company and ANCAP, Uruguay's regulatory agency.

He described the Punta del Este Half Grabens, an early- to late Cretaceous play located up to 3,500 meters below mudline in offshore Uruguay. He considers the half grabens and the overlying large deltaic system with associated turbidites to be the most promising plays for exploration in the Cretaceous section in offshore Uruguay.

Analogous discoveries include Sea Lion, Zebedee and Isobel Deep in half grabens related to the South Atlantic opening in the North Falkland/North Malvinas Basin, located 1,000-1,200 kilometers south. Partial analogs also include pre-salt discoveries in offshore Santos Basin.

López-Gamundi has spent the last 12 years working offshore Brazil and Uruguay, and he also has worked in other offshore areas of West Africa, the Gulf of Mexico, Trinidad, Colombia and Peru.

"The Cretaceous half grabens in offshore Uruguay have many similarities with the pre-salt discoveries in offshore Santos and Campos Basin to the north and the North Falkland / North Malvinas Basin to the south," he said, citing similar potential of syn-rift lacustrine and overlying sag source rocks, as well as the trapping characteristics.

The Punta del Este Half Grabens will be a part of an offshore Uruguay bid round, to be announced in mid-2017. He expects the first well to be completed by the end of 2019.

"The most likely source rock is lacustrine, like in the discoveries to the south in the North Falkland/North Malvinas basin; therefore we expect waxy oil with low GOR," said López-Gamundi.

Brazil: the Libra Block's Massive Potential

Sylvia Anjos, applied technologies general manager deputy at Petrobras, shared information from Libra, a structural/stratigraphic play in the pre-salt basins of Southeast Brazil.

Anjos, with colleagues Keith Lewis and Fernando Borges, focused on reservoirs formed by microbial carbonates deposited in a lacustrine environment, primarily mainly during the Aptian age. The reservoirs, located between five to six thousand meters deep, produce light oil with high GOR and CO_2 content.

The Libra Block is managed by a consortium formed by Petrobras (40 percent), Shell (20 percent) CNPC (10 percent) and CNOOC (10 percent). Pre-Salt Petroleum (PPSA) represents the Brazilian government and manages the Production Sharing Contract.

The consortium obtained the block as a part of the Brazilian National Petroleum agency's ANP in the first production sharing contract bid round in October 2013.

In only three years, nine wells have been drilled and three have been completed. Two others are being drilled currently.

Anjos said the Libra Team plans to drill five wells in 2017, and they expect to find more oil.

"The block is divided into three areas," she said. "So far we have concentrated in the Northwest area, and the central and Southeast areas are still in the exploratory phase."

Anjos joined the Libra Team in September 2016 after being involved in pre-salt exploration since Petrobras's first wildcat and the Libra discovery. She represents Petrobras on the Libra Joint Project Team.

"The most striking thing in the Joint Project Team is the integration of areas and teams from exploration to production," she said. "The integration with partners sharing the same office space promotes a day-to-day discussion on critical topics, which brings benefit to the Libra project."

Brazil had several pre-salt discoveries before Libra, and production is established at 1.3 million barrels of oil per day. ANP bid the Libra block for 8 to 12 BOE.

Anjos said Brazil provides tremendous opportunities for companies interested in offshore exploration and development. In addition to the pre-salt prospects in the Santos and Campos basins, the equatorial margin remains under explored with several wells yet to be drilled, she said.

"Petrobras has proven the great potential of offshore exploration and Production in Brazil," she said. "We hope for more exploration investment because we certainly have a greater potential to be revealed."

"Industry is expecting upcoming offshore bid rounds in Argentina, Brazil, Mexico and are also waiting for additional results from four key wells that will be drilled in the offshore," said Vega.

He noted that offshore will continue to be a focus throughout the Latin America and Caribbean Region, and the AAPG Region leadership team is working to provide information and training opportunities.


Atlantic Margin 3D
On trend, under-explored.
Covering one of the few 3D uncovered areas left on the Norwegian Continental Shelf, TGS' AM17 Atlantic Margin 3D survey is located in an under-explored but high potential area prime for new growth opportunities in offshore Norway. The 3D survey covers 40,000km² of mostly open acreage acquisition, comprising a variety of play models, stratigraphic and structural traps and turbidite/ fan deposits. New regional structural understanding of part areas give indications of high probability of unproven reservoirs and source rocks.
With AM17, TGS will leverage our geological and geophysical experience to bring much needed modern, high quality 3D seismic to this data, using broadband processing solution Clari-Fi™ in combination with improved denoise and demultiple techniques to further facilitate your exploration efforts and gain a better understanding of this data poor frontier region.
Acquisition Highlights:
• Commence summer 2017
• Spread: 12 x 112.5m x 8100m
• Triple Source: 12.5m shooting interval
• Bin size: 6.25 x 18.75m
• Streamer depth: 12m
• Source depth: 7m
See the energy at TGS.com

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.

Raymond's Folly: The Codell Play of the Denver Basin

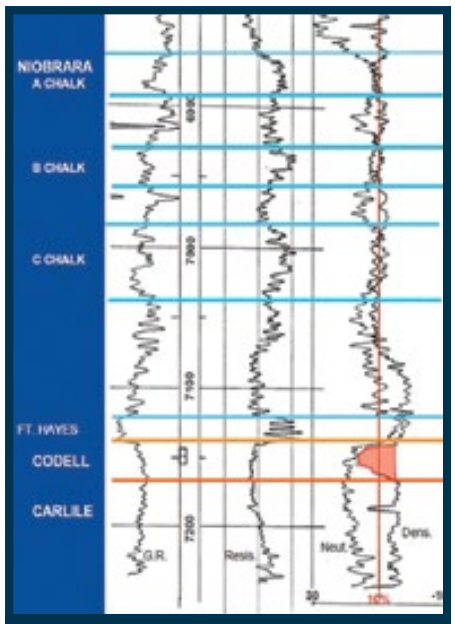
By RAYMOND PIERSON

The present day Cretaceous Codell oil and gas development in the central portion of the Denver Basin of Colorado can be attributed to an earlier effort in bringing the Codell to the attention of the industry.

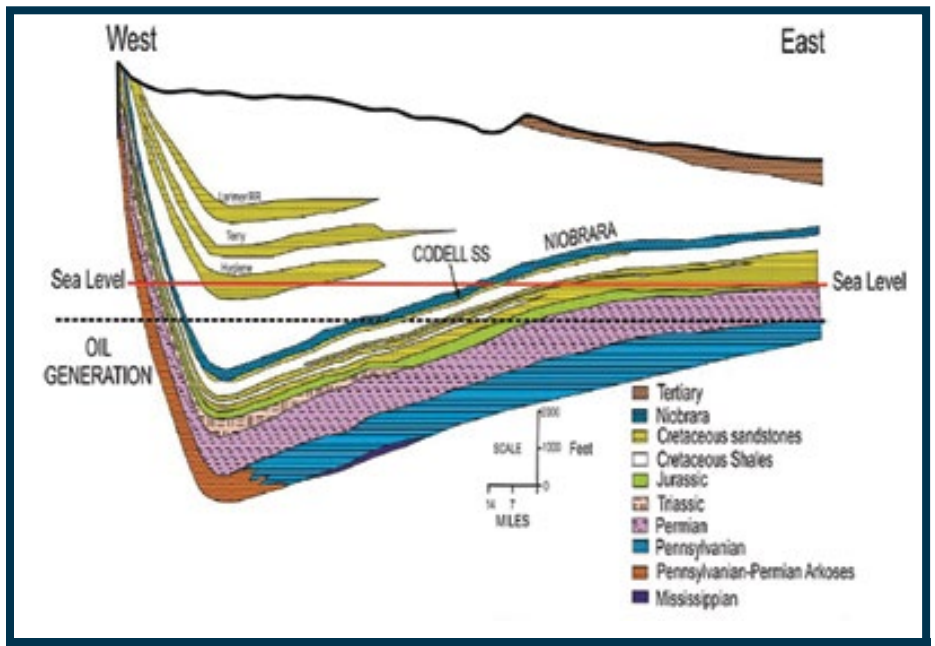
The origins of this play have been lost in history and its start can be attributed to the geological work I conducted in the early 1980s. As a student at the University Of Northern Colorado (UNC) from 1978 to 1980, I was looking at outcrops of the lower Cretaceous along the foothills east of Loveland, Colo., and came across the Fort Hays limestone and a series of silty sandstones and shales at the base. The sandstone at the base of a deep marine cold-water limestone indicated an unconformity, which was the reason for the interest in collecting a sample. While collecting a rock sample of the sandstone, I could smell the occurrence of hydrocarbons, knowing at the time that this rock was the Codell sandstone.

I started correlating from outcrop to the subsurface and across the Loveland Field into the deeper portions of the basin in the heart of the Wattenberg Field using resistivity and density logs from previously drilled wells. The wellbore signature of the Codell in open-hole logs indicated a high gamma-ray, high-density porosity and low-neutron porosity which, when the two are combined, yield the conventional gas effect cross-over. The resistivity was low and similar to the Carlile shale below. It was also noteworthy that the caliper log always seemed to indicate a washout, and upon asking a petrophysicists about this, I was informed that the high porosity was probably due to the washout and the density tool not reading correctly.

Initial mapping of the gross Codell thickness indicated that it covered many townships and was very extensive throughout the Wattenberg Field area and beyond.



Niobrara and Codell type log. NW SE NW, Sec. 8, T3N-R67W. Gustason and Sonnenberg, 2003.



Diagrammatic cross section A-A' (west to east) illustrating the asymmetric nature of the Denver Basin and the occurrence of the Codell Sandstone beneath the Niobrara Formation.

Ongoing Study of the Codell

After graduating from UNC, I went to work for Cities Service Company in Denver and was allowed under the exploitation manager, Vernon Hill, to continue working on the Codell investigation.

Continued correlation indicated that the Codell pinched out going updip and east from the Basin axis at the Codell horizon, which more or less parallels Highway 85 going north from Brighton to Greeley, Colo. This would cause a stratigraphic pinch out type trap in the updip direction, perfect for creating a big field. Further correlation to the west indicated a more or less full section of the eroded section existing all the way to outcrop along the Front Range.

Conventional log analysis indicated that the Codell was more or less 100-percent water saturated. To understand the rock, Cities Service Company needed a core, but they were not active in the Denver Basin. So in order to obtain a core for analysis, an independent named Centennial Petroleum was contacted. Cities offered to cover all costs associated with rig time and vendors if Centennial would agree to stop their drilling operations and core the Codell at a depth determined by Cities Service. Centennial agreed and a whole core of the Codell sandstone was obtained from their Futhey No. 2 well in Boulder County, Colo. The core was then sent to Roger Slatt at the Cities Service Research laboratories in Tulsa and then on to Core Labs. This occurred on July 28, 1981.

In the interim, Centennial drilled their Futhey No. 1 well to the targeted "J" sandstone for completion. One of the requested studies on the Codell core was initiated by Bob Colby, the petrophysicists working with me on the project. He wanted the true a, m, and n's for the formation resistivity factor at various brine saturates as well as core porosity and permeability. With these parameters, Bob felt that log analysis would be more descriptive than just using an Archie's type water saturation calculation. Initially when Bob conducted log analysis on the Codell he asked me what the file name should be for storage. I left that up to Bob who jokingly named the file "Raymond's Folly."

A few months passed and Centennial petroleum called me and expressed interest in the core results. Centennial's Futhey No. 1 "J" sandstone well had experienced mechanical completion difficulties resulting in tubing and a packer being stuck in the hole. If there was potential in the Codell, then Centennial wanted to attempt a completion before junking and abandoning the well. The core results had arrived a few weeks prior to Centennial's call, and were surprising in content. Bob Colby had already begun using the new a, m, and n values to recompute the water saturation calculations from selected logs across the basin.

Here is a summary of the core results:

The core of the Codell sandstone is 90-percent quartz, fine grained silt and sand and heavily bioturbated. Clays appear to be dominantly montmorillonite, illite, smectite and chlorite. These clay minerals bioturbated into and mixed with the terrigenous grains have reduced the permeability to less than 0.01 millidarcies – basically to a level almost too low to measure. The individual quartz grains were observed to contain "anastomizing fractures," which can best be described as what would happen if you took a glass marble, heated it and then dropped it into cold water. The marble fractures but does not fall apart. Some tectonic event combined with frictional heat was the suggested cause. This would generate enough heat and stress to cause the anastomizing fractures.

The a, m, and n values at various saturates from the core were determined to vary. The sample saturated with the lower salinity brine exhibited a lower formation factor than the sample saturated with a higher salinity brine. Hence, it was concluded that fresh water drilling fluids affected the true resistivity observed in open-hole well logs and this was attributed to the "conductive solids" and the Cation Exchange Capacity of the rock matrix. In addition, hydrocarbons were present in the Codell core.

Bob Colby and I had access to hundreds of "J" sandstone well logs throughout the Wattenberg Field, which were initially drilled on 320 acre spacing. Bob initially used a formation factor of 1.00 / ø^ 1.40 and an Rw of 0.11 but a more accurate formation factor was later determined. The water saturation calculations yielded values of less than 20 percent, field wide. In addition, Bob used the available sonic logs to calculate Q, or clay content, and found that the percent of clay was almost the same value as the water saturation and concluded that if water existed, it was bound in the clay minerals and would never be produced. It was concluded that the net pay covered an area no less than six townships wide and eight townships long, roughly equal to 1,728 square miles.

Productivity

What was not known was the productivity potential of the Codell.

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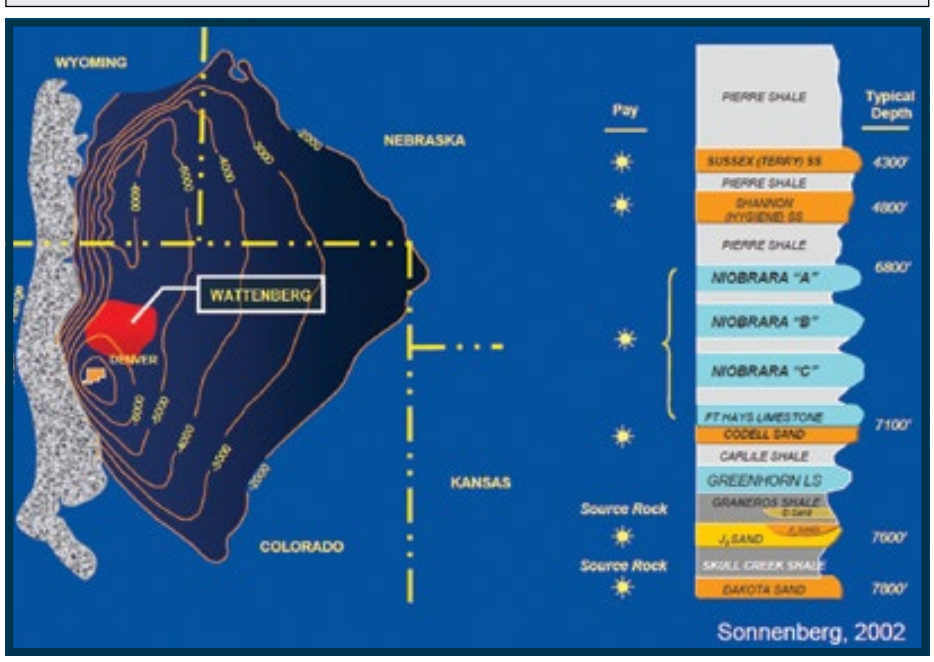
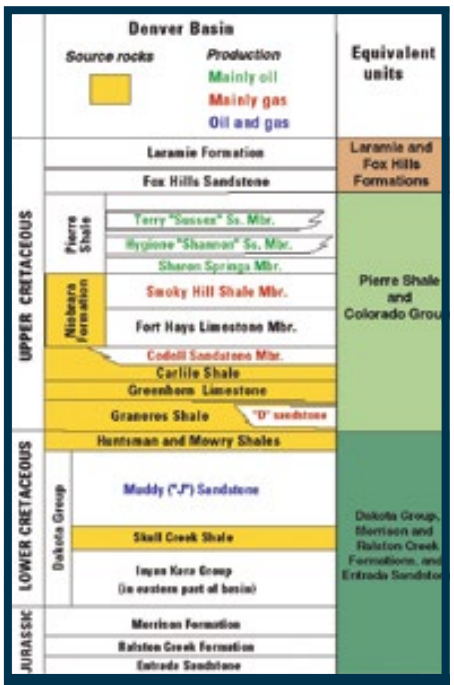
PIERSON

After serving in the United States Navy on Yankee Station during the Vietnam war, **Raymond Pierson** returned to work for Amoco Production Company in the San Juan Basin of New Mexico during the early 1970s. He graduated from the University of Northern Colorado in Greeley, Colo., with a bachelor's in Earth Sciences-Geology. Afterward, Pierson either worked directly for or consulted to companies such as Cities Service Company, Rocky Mountain Production Company, Basin Exploration Inc., Shell Western Exploration and Production Inc., Aera Energy LLC, El Paso Corporation, and finally Kinder Morgan. He retired in 2013 with a desire to consult and stay active in petroleum geology and relocated to Windsor, Colo.





Stratigraphic column of major petroleum source and reservoir rocks in Denver Basin and equivalent units as shown on figure 2. Formations labeled in green primarily produce oil; those labeled in red primarily produce gas. Rocks from which both oil and gas produced are labeled in blue.

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Based on the core results of the Futhey No. 2 and the new log analysis, it was recommended to Centennial Petroleum that the Futhey No. 1 Codell was worth a completion attempt and could perhaps prevent junking and abandoning the well. The Futhey No. 1 is located in the northeast and southeast portion of Section 26, Township 1N, Range 69 West in Boulder County, Colo. and was completed in the Codell interval. After fracturing treatment, the well tested 262 BOPD of 52-degree gravity condensate and 1.3 MMCFGPD on May 27,1981. At about the same time, Martin Exploration Management Corporation completed its No. 1 Ertl, located in the southeast and northwest Section 17, T1N-R69W by commingling the "J" and Codell sandstones and reported and IP of 250 BBLS condensate and 1.6 MMCFGPD. It is not known how much oil and gas came from which zones, but these two wells started the development of the Codell.

Amoco Production Company's first Codell completion was a recompletion of an uneconomical "Muddy J." The well was the Frank Boulter No. 1, located in the southwest quarter of Section 14, T1N-R66W. On Dec. 16, 1981 during a 24-hour test, the well flowed 102 BOPD and 1.05 MMCFGPD. Amoco with their large acreage position was in an excellent position to develop the Codell, but never did.

I later began consulting and putting together an extensive mapping project of the Wattenberg Codell. I contacted Champlin Petroleum Company and met with Allen Vandevelde and Chuck Traxler and requested a farmout of acreage in the Wattenberg Field. Champlin, at the time, understood that all the acreage was held by production by Amoco and or Champlin due to the existing "J" gas wells on 320-acre spacing. I had read the original farmout agreement between Champlin and Amoco and pointed out to Champlin that they had retained all the northeast quarter sections for themselves and only committed the "J" sandstone rights to a 320-acre spaced unit, leaving all other mineral rights to Champlin. I requested a farmout of the Codell-Niobrara minerals in every northeast quarter section

See **Contiguous**, page 27

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.

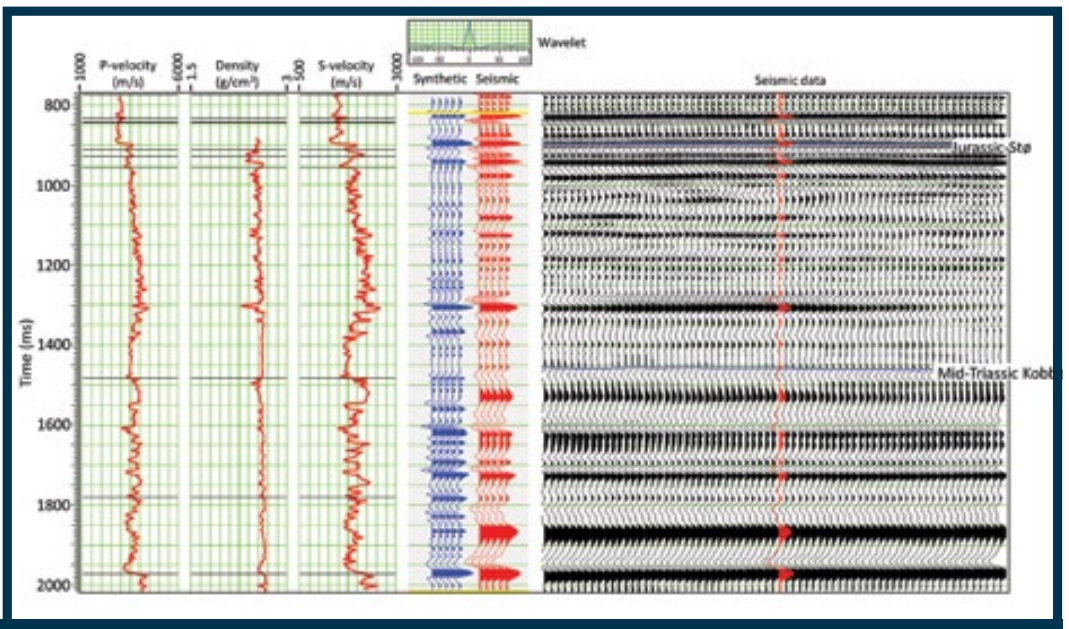

Figure 1 (left): Location map showing the western Barents Sea and some of the some of the structural elements in that area. The corridor in white thick dashed lines shows the Hoop Fault system running roughly in a NE-SW direction. The location of the seismic data volume that was picked up for the present study is shown with the yellow dashed rectangle, and falls within the Hoop Fault corridor. The drilled wells are marked in white. Abbreviations: SD-Svalis Dome; MB-Maud Basin. (Image generated using Google Earth). Figure 2 (right): Figure 2: Well-to-seismic tie for Atlantis well. The wavelet extracted from the seismic data is shown above. The traces in blue are the modeled traces and the seismic traces at the location of the well are in red.

Characterizing Shallow Seismic Anomalies

By SATINDER CHOPRA, RITESH KUMAR SHARMA, GRAZIELLA KIRTLAND GRECH and BENT ERLEND KJØLHAMAR

Many areas of the western Barents Sea host shallow as well as deep-seated hydrocarbon accumulations from which fluids are migrating to the sea floor. Evidence of past episodes of gas migration can be seen in the form of pockmarks on the sea floor as well as vertical pipes or chimneys on seismic sections. Natural gas hydrates are also present in some areas and free gas is present below the base of the hydrate stability layer, which is typically shallow.


CHOPRA

SHARMA

Such shallow migrating hydrocarbon fluids as well as free gas below the hydrates represent potential hazards for drilling deeper wells as well as the construction of sea bed installations. Thus the detailed distribution of shallow migrating fluids or the presence of gas in the shallow zones in the areas under investigation is required, for which data with high vertical and spatial resolution is required.

A portion (500 square kilometers) of the 3-D seismic volume covering over 22,000 square kilometers in and around the Hoop Fault Complex (figure 1) was picked up for carrying out a feasibility analysis aimed at characterizing the bright seismic amplitude anomalies, and also examining the fault and channel features in detail. For the present exercise, the objectives were to look for potential reservoir leads within the Stø (Mid-Jurassic) and Kobbe (Mid-Triassic) formations (figure 2), detect the potential prospects associated with direct hydrocarbon indicators (DHIs), and study the areal extent of the potential reservoirs and how they are impacted by the fault configurations present in the interval of interest.

A cursory examination of the 3-D seismic volume (by way of vertical and horizontal sections) reveals bright amplitude anomalies in the shallow intervals, interspersed with many discontinuities interpreted as faults (figure 3). Most of the bright amplitude anomalies appear to be coming from channels that show up well on the horizontal displays (time or horizon slices).

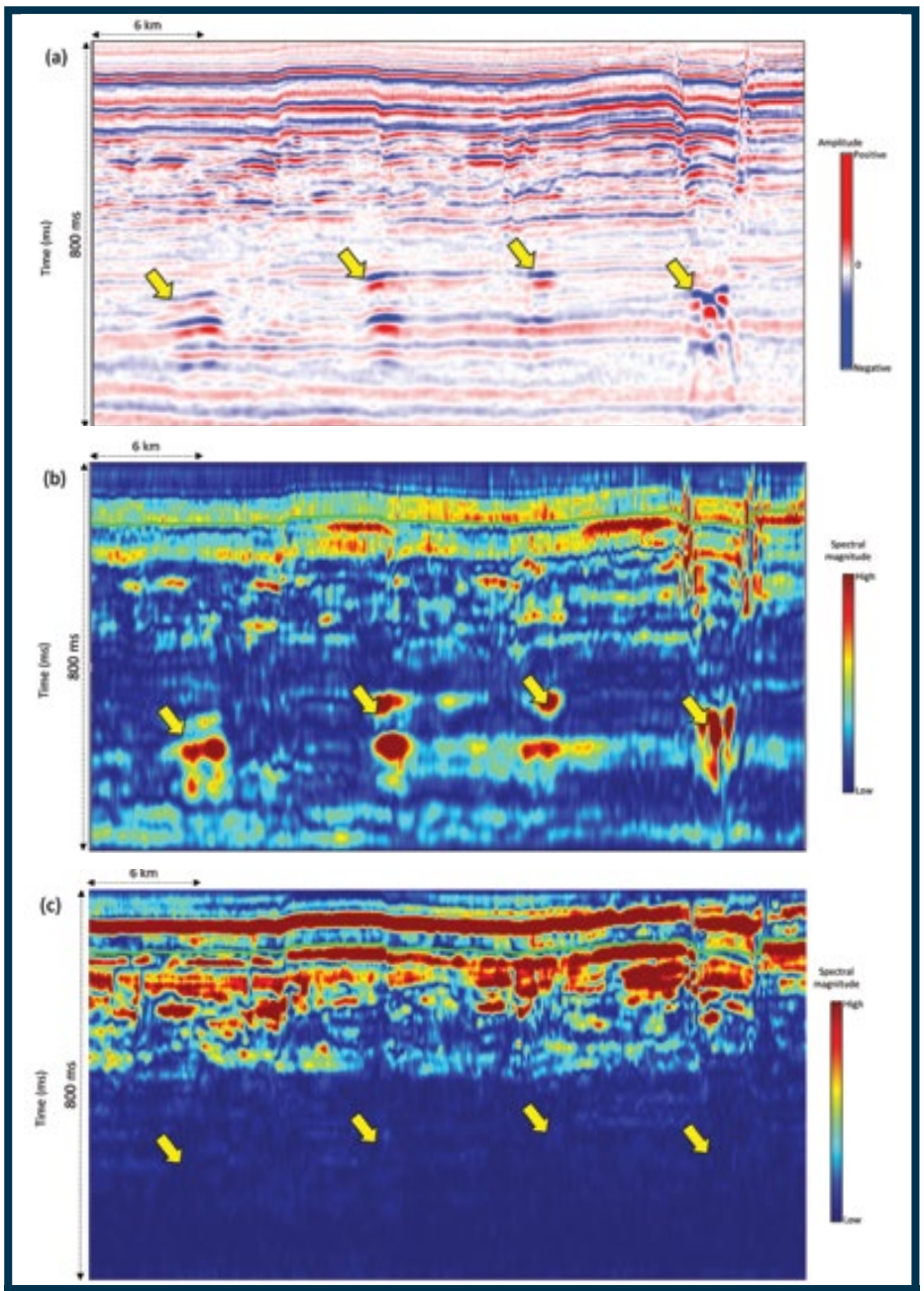

Figure 3: (a) Segment of an inline showing high amplitude anomalies. The display contrast has been reduced so as to depict these anomalies clearly. The equivalent segments of the same inline extracted from the 20 Hz and 60 Hz volumes generated using matching pursuit spectral decomposition, are shown in (b) and (c) respectively. Notice the anomalies indicated with yellow arrows exhibit high spectral magnitudes on the 20 Hz section and not on the 60 Hz section. (Data courtesy of TGS, Asker, Norway.)

There may be several reasons for an amplitude anomaly to show up on seismic data. Besides seismic processing artifacts, a clean, high-porosity wet sand, tight sand, low-saturation gas sand or a lateral change in lithology could exhibit a high amplitude anomaly. Similarly, streaks of salt, volcanics, or carbonates could indicate anomalies. Needless to mention, a combination of one or more of the above-stated geologic conditions could exhibit false amplitude anomalies. Processing of seismic data in an amplitude-friendly way and gaining a good knowledge about the geology of the area under investigation together with the expected seismic response through modeling are established ways of lowering the uncertainty in the analysis.

Distinguishing seismic anomalies associated with the presence of hydrocarbons from those that are not could be challenging. But it is important that such challenges be addressed so as to prevent costly drilling failures.

A straightforward choice for accomplishing this would be to put the data through impedance inversion (so pockets of low-impedance/density, indicative of hydrocarbons or high porosity can be picked up) and also generate one or more discontinuity attributes such as coherence and curvature, so that the definitions of the channels and faults stand out clearly. Thus by adopting a workflow that entails the generation of P-impedance, S-impedance and density attributes and examining these or other derived attributes in crossplot space, it is possible to identify the fluid-associated anomalies.

Spectral Decomposition Application

It is always instructive to carry out alternative workflows with different tools and compare the results for assessing the uncertainty in the exercise. Keeping in line with this strategy, we explore the application of spectral decomposition to the data at hand. The decomposition of the seismic signal band into constituent

Continued on next page


KJØLHAMAR


GRECH

Bent Erlend Kjølhamar holds a master's degree in geology from the University of Oslo, and has been working for TGS for the last 20 years. He is TGS director of project development for Europe and Russia.

Graziella Kirtland Grech holds a doctorate in exploration geophysics from the University of Calgary, Canada. She has over 20 years' industry experience in both technical and leadership roles. Since 2012 she has been the director for processing and reservoir services at Arcis (a TGS company).

Continued from previous page

frequencies is referred to as spectral decomposition. It is a useful tool that has important applications including differentiation of lateral and vertical lithologic and/or pore-fluid changes as a DHI indicator, and seismic geomorphological applications aimed at delineating stratigraphic traps. For more details, the readers are encouraged to look through the December 2013, January to March 2014 and March 2016 Geophysical Corner articles published in the EXPLORER.

In the context of DHIs, the basic premise is that reflections from fluid-saturated rocks are frequency-dependent. It is well known that such reflection coefficient (water/gas) ratios are three times stronger at 14 Hz than at 50 Hz, and thus the observed reflection amplitudes can be used for detecting liquid saturated areas in thin-porous layers. In the presence of hydrocarbons, the encasing formations selectively reflect some particular frequencies and not others, leading to high amplitudes on seismic sections. This is due to the fact that higher frequencies suffer higher attenuation while traversing hydrocarbon reservoirs. In the event the reservoirs are thin, the tuning of reflections also exacerbates the amplitude responses from reservoirs. It has been demonstrated in the geophysical literature that the instantaneous spectral analysis of seismic data shows low-frequency modes of the seismic wavefield providing more useful information for the study of fluid-saturated rocks.

We used the matching pursuit method of spectral decomposition on the data at hand and noticed that many of the high amplitude anomalies are associated with higher spectral amplitudes. In figure 3a we show a segment of inline from the input seismic volume showing some high amplitude anomalies. We plot the equivalent spectral magnitude displays at 20 Hz and 60 Hz and are shown in figures 3b and c. Notice the high spectral magnitude values seen at 20 Hz, but not on the 60 Hz display, even though the bandwidth of the data extends to above 80 Hz. We do not claim that this analysis is conclusive, but it is a method for direct detection of hydrocarbons, and can be taken forward for confirmation.

See **Barents Sea**, page 26

ACE 2017

The Event of the Century

By BRIAN ERVIN, EXPLORER Managing Editor

After a century in the making, AAPG's100th anniversary Annual Convention and Exhibition is over, and it was a big hit, by all accounts.

"Overall, I think ACE 2017 went very well," said Dave Rensink, general chair of the ACE 2017 Organizing Committee.

The event was April 2-5 at the George R. Brown Convention Center and saw nearly 7,800 in attendance.

Members of the AAPG 100th Anniversary Committee began work on ACE 2017 a decade ago, and despite planning "in an environment of $80 to $100/barrel oil and… executing those plans in a $50/barrel reality," as Rensink framed it, it was an event to be remembered into the next century, and many of its events and presentations will see deeper coverage in this and future issues of the EXPLORER.

One of the first major events was a forum held by the Professional Women in Earth Sciences Committee (PROWESS) honoring 100 years of women in petroleum geology, which is covered in this issue (see page 24).

The following day, there was the History of Petroleum Geology forum, which focused on the past 100 years of petroleum geology and the history of AAPG.

There were also two Discovery Thinking forums, which were the culmination of a painstaking effort begun by current AAPG President-elect Charles Sternbach 10 years ago when he co-founded the Discovery Thinking program to celebrate "100 Who Made a Difference" in time for the centennial.

There was also the "Preservation of Geoscience Data" exhibit on display, demonstrating a range of core material, data and media spanning the last 100 years of oil and gas exploration.

The 100th Anniversary Gala featured a keynote address by Pulitzer Prize-winning energy researcher IHS Markit Vice Chairman Daniel Yergin, which will be covered in next month's EXPLORER.

Another major attraction was the special event held by AAPG's Division of Environmental Geosciences and the Energy Minerals Division: "The Next 100 Years of Global Energy Use: Resources, Impacts and Economics," which featured speakers like AAPG Past President and founder of the Switch Energy Project Scott Tinker, and BP America Senior Vice President Cindy Yeilding. The event was previewed in the January EXPLORER.

Of course, the technical program is the centerpiece of any ACE, and this year was no exception.

"I thought the technical program was one of the highlights of this year, and all of the credit for that goes to Craig Shipp, Amy Sullivan, and Carl Steffensen," said Rensink.

"The technical program was successful because of the effort Craig, Amy and Carl put into it. Over 2,300 abstracts were submitted, and there were less than 1,300 oral and poster slots available. I think the numbers caused the rejection rate to be higher than normal, and generally improved the quality of the presentations."

CONGRATULATIONS TO AAPG FOUNDATION'S 2017 GRANTS-IN-AID RECIPIENTS

The American Association of Petroleum Geologists Foundation and the Education Awards Committee are proud to announce the Grants-in-Aid recipients for 2017.

The Foundation's Grants-in-Aid program is a highly competitive grant program promoting research in the geosciences. Grants are made to provide financial assistance to master's or doctorate level students whose graduate-level research has application to the search for and development of petroleum and energy mineral resources, and/or related environmental geology issues.

In 2017 the program awarded 126 graduate students across the world with a total of $274,750 in research funds. These funds are available annually thanks to our named grants, most of which bear the name of generous donors and innovators in the energy industry.

AUSTRALIA

University of Adelaide
- Tayallen Velayatham, *SEAPEX Named Grant*

University of Western Australia
- Rosine Louise Riera, *Grants-in-Aid Fund*

BRAZIL

University of Campinas
- Saeid Asadzadeh, *Grants-in-Aid Fund*

CANADA

McMaster University
- Wen Lin, *Martin D. Hewitt Named Grant*

Simon Fraser University
- Cheryl Hodgson, *J. Elmer Thomas (Past Presidents) Memorial Grant*
- Lucian Rinke-Hardekopf, *Grants-in-Aid Fund*
- Nakari Diaz, *Grants-in-Aid Fund*

University of Alberta
- Scott Botterill, *Grants-in-Aid Fund*
- Yunfeng Chen, *L. Austin Weeks Memorial Grant*

University of Calgary
- Emma Percy, *R.E. McAdams Memorial Grant*
- Sean Murphy, *Harry and Joy Jamison Named Grant*

University of Ottawa
- Matthew Braun, *Mruk Family Named Grant*

CHINA

China University of Petroleum-Beijing
- Tao Hu, *David Worthington Named Grant*
- Wenyang Wang, *Allen and Eleanor Martini Named Grant*
- Xiao Feng, *Gustavus E. Archie Memorial Grant*

NEW ZEALAND

The University of Auckland
- Stephen Brennan, *Gustavus E. Archie Memorial International Grant*

NIGERIA

University of Lagos
- Tolulope Abosede Fadehan, *Jay M. McMurray Memorial Grant*

RUSSIA

Gubkin Russian State University of Oil and Gas
- Polina Kupchikhina, *Marilyn Atwater Memorial Grant*

UNITED KINGDOM

Durham University
- Kristian Hardman, *The Institut Français du Pétrole Grant*

Heriot-Watt University
- Anastasia Polymeni, *Grants-in-Aid Fund*
- Christian Onwunyili, *Grants-in-Aid Fund*

Keele University
- Ross Pettigrew, *Gustavus E. Archie Memorial Grant*

Plymouth University
- Grant Cole, *Horst and Jessie von Bandat Memorial Grant*

University of Manchester
- Arne Fuhrmann, *Merrill W. Haas Memorial Grant*
- Euan Soutter, *R. Dana Russell Memorial Grant*

University of Oxford
- Israa Abu-Mahfouz, *Donald F. Towse Memorial Grant*
- James King, *Gustavus E. Archie Memorial International Grant*

UNITED STATES OF AMERICA

ARIZONA

Northern Arizona University
- Daniel Conrad, *Grants-in-Aid Fund*

University of Arizona
- Susana Henriquez, *Raymond D. Woods Memorial Grant*

ARKANSAS

University of Arkansas
- Julie Cains, *Marta S. Weeks Named Grant*

CALIFORNIA

California State University, Sacramento
- Marissa Loustale, *Roger W. Stoneburner Memorial Grant*

Stanford University
- Samantha Ritzer, *Lawrence W. Funkhouser Named Grant*
- Xiaowei Li, *John E. Kilkenny Memorial Grant*

University of California, Riverside
- Shelly Wernette, *David Worthington Named Grant*

COLORADO

Colorado School of Mines
- Daniel Halford, *John and Erika Lockridge Named Grant*
- Hang Deng, *Paul Danheim Nelson Grant*
- Jianqiao Wang, *John and Erika Lockridge Named Grant*
- Kristine Zellman, *John and Erika Lockridge Named Grant*
- Matthew Steidtmann, *John and Erika Lockridge Named Grant*
- Mimi Do, *Suzanne Takken Memorial Grant*
- Rosemarie Fryer, *Grants-in-Aid Fund*

FLORIDA

University of Miami
- Anna Ling, *Robert K. Goldhammer Memorial Grant*
- Laura Rueda Sanchez, *Grants-in-Aid Fund*
- Viviana Diaz, *Norman H. Foster Memorial Grant*

GEORGIA

University of Georgia
- Christopher Smith, *Bernold M."Bruno" Hanson Memorial Environmental Grant*

INDIANA

Indiana University
- Graham Johnston, *Alexander and Geraldine Wanek Memorial Grant*
- Zhiyang Li, *Donald A. and Mary O'Nesky Named Grant*

KANSAS

Kansas State University
- Adam Lane, *John W. Robinson Named Grant*
- Kale Janssen, *Barrett Family Named Grant*

University of Kansas
- Elson Core, *Wallace E. Pratt Memorial Grant*
- Isaac Allred, *Grants-in-Aid Fund*
- James Colgin, *Richard C. Hasson Memorial Grant*
- Kathleen Graham, *Grants-in-Aid Fund*
- Keelan Umbarger, *Sherman A. Wengerd Memorial Grant*

KENTUCKY

University of Kentucky
- Alex Reis, *Grants-in-Aid Fund*
- Stephanie Sparks, *Arthur A. Meyerhoff Memorial Grant*

LOUISIANA

Louisiana State University
- Adam Gostic, *Garth W. Caylor Memorial Grant*
- Edwin Bomer, *Raymond C. Moore Memorial Grant*
- Elizabeth Levy, *W. David Wiman Memorial Grant*
- Rickey Bartlett, *Edward B. Picou Named Grant*

MICHIGAN

University of Michigan
- Brian Konecke, *Alexander and Geraldine Wanek Memorial Grant*

MISSISSIPPI

Mississippi State University
- Anh Nguyen, *Grants-in-Aid Fund*

MISSOURI

Missouri University of Science and Technology
- William Chandonia, *Harold J. Funkhouser Memorial Grant*

University of Missouri-Columbia
- David Nymberg, *M. Ray Thomasson Named Grant*

NEBRASKA

University of Nebraska - Lincoln
- Ryan Mustacato, *Rodney A. Bernasek Memorial Grant*
- Shamar Chin, *David Worthington Named Grant*

NEVADA

University of Nevada, Reno
- Jason Craig, *Grants-in-Aid Fund*

NEW HAMPSHIRE

University of New Hampshire
- Sarah Turner, *Fred A. and Jean Dix Named Grant*

NEW JERSEY

Rutgers University
- Bari Hanafi, *Grants-in-Aid Fund*

NEW MEXICO

New Mexico State University
- Jonathan Ingram, *Gordon I. Atwater Memorial Grant*

University of New Mexico
- Jacob Thacker, *Edward C. and Caroline Beaumont Named Grant*

NEW YORK

Binghamton University
- Bethany Royce, *Grants-in-Aid Fund*
- Kuwanna Dyer-Pietras, *Horst and Jessie von Bandat Memorial Grant*

Cornell University
- Jonathan Casey Root, *Kenneth O. Stanley Memorial Grant*

Syracuse University
- Amanda Schulz, *Pittsburgh Association of Petroleum Geologists Named Grant*

University at Buffalo
- Tayler Schweigel, *Richard W. Beardsley Named Grant*

NORTH DAKOTA

University of North Dakota
- Lingyun Kong, *J. Ben Carsey Sr. Memorial Grant*

OHIO

Bowling Green State University
- Zachary Cotter, *Fred A. and Jean Dix Named Grant*

Kent State University
- Courtney Smith, *Ohio Geological Society Named Grant*

Miami University
- Patrick Cullen, *AAPG Eastern Section Named Grant*

The Ohio State University
- Fengyang Xiong, *Michael S. Johnson Named Grant*

OKLAHOMA

Oklahoma State University
- Georgina Lukoczki, *Frederick A. Sutton Memorial Grant*
- Ibukunoluwa Bode-Omoleye, *John H. and Colleen Silcox Named Grant*
- John Gray, *Grants-in-Aid Fund*
- Justin Allen, *Grants-in-Aid Committee Named Grant*
- Liang Xue, *Grants-in-Aid Fund*
- Mercy Achang, *Grants-in-Aid Fund*
- Oyeleye Adeboye, *R.E. McAdams Memorial Grant*
- Phillip Bailey, *James E. and Elloie B. Wilson Memorial Grant*
- Yulun Wang, *Duncan A. McNaughton Memorial Grant*

University of Oklahoma
- Emilio Torres Parada, *Jon R. Withrow Named Grant*
- Jerson Tellez, *Jon R. Withrow Named Grant*
- Kelsey Lewis, *Jon R. Withrow Named Grant*
- Son Dang, *Jon R. Withrow Named Grant*

OREGON

Oregon State University
- Carolyn Gombert, *Kenneth H. Crandall Memorial Grant*

SOUTH CAROLINA

Coastal Carolina University
- Ashley Long, *Grants-in-Aid Fund*

University of South Carolina
- Patrick Duff, *Frank E. Kottlowski Memorial Grant*

TEXAS

Baylor University
- Jared Hanson, *Donald R. Boyd Memorial Grant*

Rice University
- David Blank, *Classen Family Named Grant*

Southern Methodist University
- Kate Andrzejewski, *William E. Gipson Named Grant*

Texas A&M University
- Clyde Findlay, *Michel T. Halbouty Named Grant*
- Roy Conte, *James E. Hooks Memorial Grant*
- Tanner Mills, *Michel T. Halbouty Named Grant*
- Telemachos Manos, *James W. Milliken Memorial Grant*
- Zihui Gao, *James E. Hooks Memorial Grant*

Texas Tech University
- Travis Sparks, *Jean G. Funkhouser Memorial Grant*
- Giovanni Zanoni, *Grants-in-Aid Fund*

University of Houston
- Carolina Ramon Duenas, *Grants-in-Aid Fund*
- Lucien Nana Yobo, *Kenneth H. Crandall Memorial Grant*

University of Texas at Arlington
- Md Golam Kibria, *Hugh D. Miser Memorial Grant*

University of Texas at Austin
- Emily Beckham, *Meckel Family Named Grant*
- Kelly Thomson, *William Dow Hamm Memorial Grant*
- Keri Belcher, *Grants-in-Aid Fund*
- Tomas Capaldi, *Grants-in-Aid Fund*

University of Texas at El Paso
- Andre Llanos, *Grants-in-Aid Fund*
- Kate Grisi, *Thomas A. Hendricks Memorial Grant*

UTAH

University of Utah
- Ellen Reat, *Arthur A. Meyerhoff Memorial Grant*
- Gabriela St. Pierre, *Nancy Setzer Murray Memorial Grant*
- Kate Schwehr, *David Worthington Family Grant*
- Peter Steele, *Robert and Carolyn Maby Memorial Grant*

Utah State University
- Krishna Borhara, *Ike J. Crumbly Minorities in Energy Grant*
- Sarah Wigginton, *Grants-in-Aid Fund*
- Skyler Sorsby, *Peter W. Gester Memorial Grant*

WEST VIRGINIA

West Virginia University
- Rawlings Akondi, *John Teagle Memorial Grant*
- Vikas Agrawal, *Grants-in-Aid Fund*

WISCONSIN

University of Wisconsin-Madison
- Andrew Walters, *Robert and Carolyn Maby Memorial Grant*

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Toll-Free Number (US and Canada): 855-302-2743 • Email: foundation@aapg.org • Website: foundation.aapg.org

Progress and Prowess: 100 Years of Pioneers

By EMILY SMITH LLINAS, EXPLORER Correspondent

Women have come a long way in the last 100 years, transforming the workplace and the oilfield as they've fought their way into roles previously considered off-limits to them. As much as attitudes and expectations have changed, however, challenges remain as women continue to blaze new trails in the industry.

These were the recurring themes at the Pioneering Women in Petroleum Geology Forum, which celebrated AAPG's first 100 women members and 100 years of women in petroleum geosciences. It was part of the Association's centennial celebration at the Annual Convention and Exhibition (ACE) in Houston last month.

The forum, organized by AAPG's Professional Women in Geosciences (PROWESS) committee, the Association of Women Geosciences and the Society of Exploration Geophysicists Women's Network, highlighted women's impact on the oil and gas industry from the early 20th century to today.

The Forum was the brainchild of Robbie Gries, president at Priority Oil & Gas LLC, who served as AAPG's first woman president in 2000-01.

"Anticipating the 100th anniversary of AAPG, we wanted to find a way for AAPG women to contribute...and went with tracking down the first 100 female AAPG members," Gries said. "This led us to discover that the female presence in the geological side of the oil and gas business was also 100 years old, a fact unknown to any of us when we started this!"

Gries's research led her to write a book, "Anomalies: Pioneering Women in Petroleum Geology," in which she profiles 100 influential women in the oil and gas industry from 1917-2017. She autographed books throughout the forum and the ACE event.

Robbie Gries and husband David E. Bailey dressed as 1915 geologists. Gries won second place in the costume contest organized with the AAPG Young Professionals, featuring business and work attire that was part of a woman geologist's "uniform" over the past century.

Barbara Tillotson, geoscience manager at RPM Energy Management and chair of the PROWESS special interest group, said Gries's and the PROWESS team's dedication to the topic motivated her to help organize the forum, which took years of planning.

"The research for this event has been in the works for roughly five years," she said. "It was difficult to find information for most of these Pioneering Women and the first 100 women of AAPG."

The all-day event featured expert speakers, panel discussions, networking and the world premiere of a AAPG's new documentary: "Rock Stars: Pioneering Women in Petroleum Geology."

The documentary examines and celebrates the century-long history, achievements and advancements of women in petroleum geosciences and highlights the cultural, societal and professional characteristics marking the times in which they lived and worked.

Evolving Challenges

Gries described how women's role in the workplace changed as society changed. During World War II, women were expected work while men fought overseas. When the men came home, women were expected to go home, too.

Carolyn Miracle Ross, retired international petroleum geologist, recalled preparing for a job interview in the early 1960s. Ross received the National Science Foundation Talent Search Award, attended university on a four-year scholarship in geology, and graduated with honors, on the Dean's list, with Phi Beta Kappa recognition.

"The man I interviewed with looked at my resume and said, 'Oh great – we need a really good geological secretary!' My academic achievements meant nothing, and all they saw was a woman, which of course, in their minds meant I *could* type and *should* be a secretary, even though I couldn't actually type," she said.

"The prevailing attitude for not hiring me as a geologist (and other women professionals) was, 'If you're married, you'll get pregnant and leave.' If a woman was not married, then the attitude was, 'If you're single, you'll get married and leave.' That attitude was not at all concerned that men often leave too, for a better job, or more money, or for family reasons."

Panelists and participants noted that discrimination still exists today in more subtle ways.

Continued on next page

The Pioneer Women in Petroleum Geology Forum included a costume contest organized by AAPG Young Professionals in which period costumes from various periods over the last century were worn.

Continued from previous page

They discussed the "parental attitudes" of some company managers, who attempt to make decisions they believe are best for employees and their families.

Gries noted that in some cases, men are more likely to be offered promotions if their wife is a stay-at-home mom.

"If she is not working, he is free to accept a promotion and move," she said. "If she has a successful career he may not be able to have as many options."

Emily Glick, geologist at EQT Production Company, shared the challenges she faced when she returned from maternity leave and wanted to pump breast milk at work.

"The company had two 'sick rooms' for 800 employees, and that's where we had to go to pump," she said. "Often there were lines, and we had a hard time getting to meetings. Sometimes I would have to skip pumping to make it to a meeting."

Glick got a group of mothers together, and they eventually convinced the company to set up two additional lactation rooms for employees. Now she is working with coworkers to establish standardized paid leave for fathers after the birth or adoption of a child, as well as official formal paid maternity/adoption leave, so employees don't have to use short-term disability leave and unpaid Family Medical Leave Act (FMLA) time.

International Perspectives

Challenges for women in the energy industry are not unique to the United States.

Sylvia Anjos, applied technologies general manager deputy at Petrobras, shared the evolution of women's involvement in Brazil's petroleum industry.

"In 1961 Petrobras offered its first geology class and started training petroleum geologists," she said. "It took 15 years for women to get into the company, and when they did, they started in paleontology."

"Women couldn't go to the rig because there were no women's restrooms," she said. "Nowadays it's easier for women to enter the industry, but getting an executive position not so simple."

Maria Antioneta Lorente, stratigraphic services manager at ALS Oil & Gas, shared her experiences working in Venezuela from the mid-1970s until the late 1990s, when the country's oil became national property.

"At that time the country was more open to having women in professional careers. It was possible to keep your family and your job, but (women) had to work like two people," she said.

Lorente said she and her husband were fortunate to work in a company that employed them both.

"Spouses could work at the same company, but they had to be in different departments," she said. "My husband was in production; I was in exploration."

Finding the Right Partner

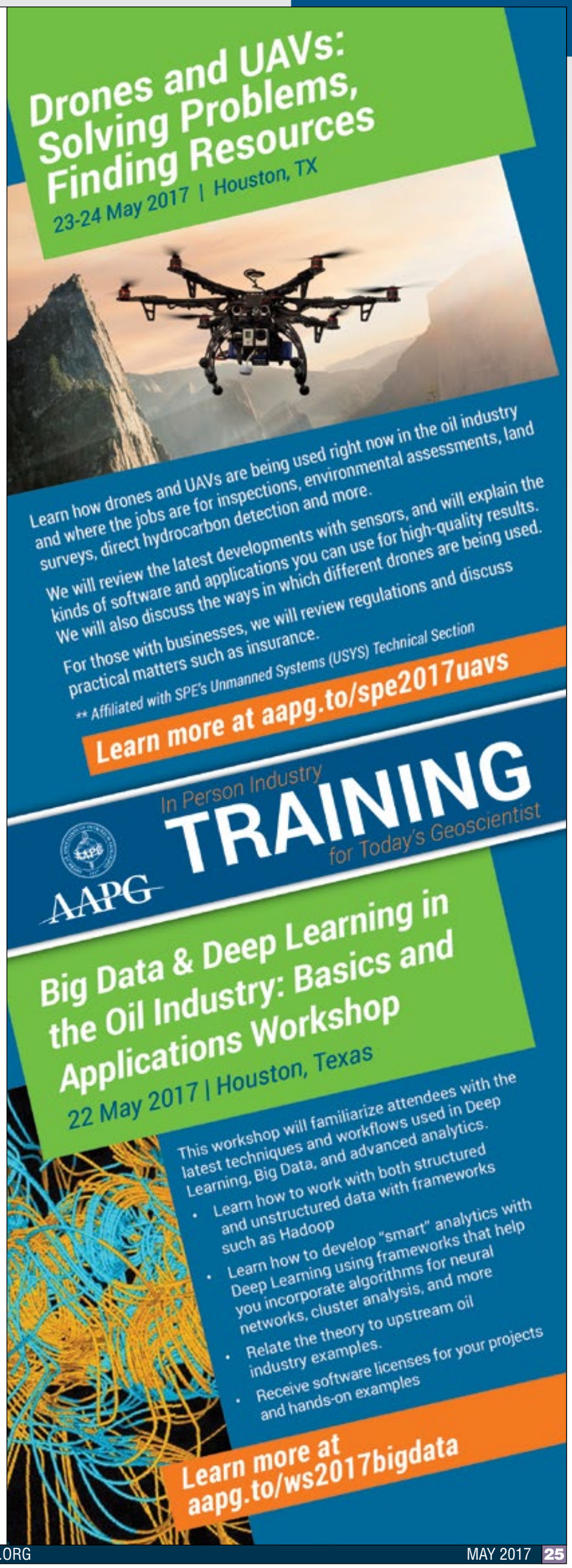
Panelists also emphasized the impact spouses can have on women geoscientists and their careers.

"The decision of you who partner with in life is so critical," said Ione Taylor, executive director of the Earth and Energy Resources Leadership Program at Queens University. "Women have two jobs. You work at the office, and then you come home and work. If you have a true partner it helps."

Taylor and her husband found a balance by pursuing individual interests.

"He had no interest in management. He wanted to stay on the technical side, so I went into management," she said.

See **Pioneer**, page 27



PROTRACKS

SIGs and TIGs Open to Non-members

By JONATHAN P. ALLEN, Young Professionals Co-Chair

With all the excitement of the 100th anniversary of AAPG at the Annual Convention in Houston last month, there was a bit of news that you may have missed: there is now a way for AAPG Members and non-members alike to join the Special Interest Groups (SIGs) and Technical Interest Groups (TIGS).


ALLEN

This is exciting news for the YPs, as one of the YP SIG's main challenges has been connecting and communicating with not only AAPG Members who identify as young professionals, but also with all Members who support the mission of the YPs and want information about our current activities.

Not Just For Members

The Association leadership has made the decision to allow non-members to temporarily join SIGs and TIGs to preview what these groups have to offer. The idea is to allow a prospective Member to sign-up for a SIG/TIG, but their membership will expire after one year if he or she still hasn't become an AAPG Member.

This is an excellent way to introduce people to the AAPG community and ultimately attract more Members to the Association. Our hope is that YP members from our sister societies and beyond will use this approach to learn more about who the AAPG YPs are, what we are doing and decide that this is a group they would like to join and become actively involved with.

How Do I Join?

I know everyone one of you – at least, all the non-members reading this – is asking yourself, "This is great! How do I join?"

I'm glad you asked. Joining is easy:

- First, navigate to the SIGs and TIGs websites. You can do that by either going to the homepage at AAPG.org, and under the 'Career' tab, select "Special Interest Groups (SIGs)" or "Technical Interest Groups (TIGs)". Alternatively, you can go directly to the pages at AAPG.org/sigs or AAPG.org/tigs. As of this writing, there are two SIGs and 15 TIGs you can join.
- Second, be sure you're logged into your AAPG account. If you don't have an account, you must create one. Then, join as many of the SIGs and TIGs that interest you.
- Third, manage your subscription settings. You can select whether to receive email communication from the SIG/TIG.

I would strongly encourage everyone who is interested in the YPs to join the YP SIG and subscribe to our communications. The current SIG leadership are looking forward to communicating more effectively with our members and providing relevant products and services. As AAPG looks at our next 100 years, the YPs are excited to be involved with the future of the organization and we look forward to seeing our SIG membership grow.

Looking for more ways to communicate with the YP SIG? Follow us on Twitter and Instagram @aapgypsig, like our page on Facebook or join our LinkedIn group.

IN MEMORY

Frank Adler, 96
Littleton, Colo., Feb. 3, 2017
David Birsa, 66
Spicewood, Texas, April 21, 2016
Thomas Fitzgerald, 93
Alexandria, Va, Feb. 13, 2017
Paul Krutak, 82
Canon City, Colo., Dec. 7, 2016
Thomas Ladd, 68
Bakersfield, Calif., Feb. 27, 2017
William LeMay, 82
Aiken, S.C., April 5, 2016
Richard Ornelas, 90
Middleburg, Va., Jan. 26, 2017
Georges Pardo, 96
Naples, Fla., March 1, 2017
Harold Peterson, 83
Austin, Texas, March 16, 2017
Kurt Sickles, 69
Bakersfield, Calif., July 1, 2015
Marvin Smith, 95
Houston, Texas, Dec. 13, 2016
John Wesselman, 89
Montgomery, Texas, Sept. 6, 2016
Thomas Wright, 86
San Anselmo, Calif., Nov. 17, 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.)

Barents Sea

from page 21

Besides improving the quality of the existing seismic data through reprocessing (with the latest algorithms) and their integration with borehole data, the state-of-the-art acquisition of fresh data with more powerful acquisition technology are being carried out in the Barents Sea. In order to improve the quality of the data being used for interpretation and analysis as well as effectively derisk the prospects ahead of drilling, the state-of-the-art technology is being used for its collection. Besides this, diverse data types, both geological and geophysical, are being brought together so as to come up with an integrated assessment for the prospects. Multibeam seafloor mapping and sampling is also being done by some of the operators in that area. Plans are also under way for integrating all this data for mitigating exploration risk.

Pioneer
from page 25

What Makes a Pioneer

Claire Farley, vice chairman with KKR's Energy and Infrastructure Business, provided a luncheon keynote speech highlighting her experience in the oil and gas industry and characteristics of pioneers.

She opened by sharing her experience as a new-hire at Texaco in 1989.

"When I started I didn't know I was a woman. I was a geologist. I was invited to participate in this high-tech treasure hunt," she said, admitting being a bit naïve at the time.

"I thought 'Women aren't here. They must be running fashion companies or health care.' I didn't think it was that they didn't want women. I didn't worry about proving to my colleagues that I was up to the job."

Farley's perspective changed a bit as she spent more time in the industry. She recalled having a meeting with a new well site manager, who didn't expect the geologist to be a woman.

"He looked at me and said, 'They done sent me a lot of things before but they never sent me a little girl.' It's a good thing I laughed because he meant it as a joke," she said. "He taught me all kinds of things about that rig, and we remained friends for years."

Farley noted that while all work environments have challenges, there is always a way to move forward.

"Tune out the naysayers. Go through the gatekeepers. Find a way though," she said.

Farley also shared her definition of a pioneer: determined, passionate, curious and confident, with an appetite for risk. "Men don't have a monopoly on the traits, use them," she said, "But use your own voice. Don't hesitate. Be yourself."

Useful Advice

Panelists provided plenty of wisdom for forum participants.

Panelist Susan Morrice, founder and president of Belize Natural Energy, emphasized the importance of creativity and motivation.

"Wallace Pratt gave us a key to unlocking our position. 'Oil is found in the mind….' It took me on a course to think about what is

Sherilyn Williams-Stroud, one of the narrators of the "Rock Stars" documentary.

in our mind. What holds us back? How do culture, parents, teachers and technology affect our mind? That's where our creativity comes from," she said.

Morrice said creativity and determination were essential to founding and running her company.

"That is how we discovered the first oil in Belize when everyone said I was stupid and there was no oil in Belize," she said. "Now in Belize we have new philosophy. We don't just take the money out. We are for nature and people."

Taylor highlighted the importance of developing personally and professionally while gaining technical knowledge.

"You have to be 100 percent technically competent, but seek education beyond the technical aspects," she said. "Understand the business. How does the company make money? Focus on relationships and understanding. You don't have control over the price of oil or the attitudes of your co-workers. You can control how you develop."

A Successful Event

Tillotson described the forum as "extremely successful" and she said she received multiple positive comments on the documentary, the panel engagement and the networking ability.

"We sold out the event, which was listed for 200 attendees," she said.

"History is a great humbling exercise... putting our lives into the perspective of 100 years of progress is a powerful dose of medicine," she said Gries.

Continguous
from page 19

of every odd-numbered section in the Wattenberg Field on the UPRR right-of-way.

Then in early 1985, I contacted a company in Fort Collins, Colo., named Basin Exploration Incorporated and brought to them the basic farmout proposal. Basin met with Champlin and a farmout proposal was drafted on March 21, 1985. Basin agreed to drill 20 drill-to-earn wells and have a continual drill-to-earn right on the approximately 7,000 net mineral acres in the Wattenberg Field. I became the vice president of exploration and production for Basin Exploration.

'Contiguous' or 'Continuous'?

Since that time, thousands of Codell-Niobrara wells have been drilled in the Denver Basin and it is still being heavily developed to this very day. In an article that appeared in the business section of the Denver-based Rocky Mountain News on Sunday, July 4, 1982, I was quoted during an interview as saying "I predict that the Codell will be the largest continuing producing reservoir in the Rocky Mountains."

What I actually said was "contiguous," not "continuous," but the Codell play is now 35 years old and thousands of wells have been drilled and thousands more are scheduled to be drilled along with the emerging Niobrara play. The Codell was considered to be a non-typical reservoir from the beginning, and it has proved to be all that it was determined to be at the onset of the study more than 36 years ago.

Thus, what I began as a study of "Over Looked Oil and Gas in the Loveland Area" at the University of Northern Colorado under the guidance and supervision of William Nesse and Lee Schropshire became the Codell play that has endured until this very day. There have been many players and the industry has changed over time, but the initial geological interpretation was sound and over time has proved to be all that it that it was initially determined and suggested to be, even if at first it might have seemed to be "Raymond's Folly."

AAPG's Foundation Trustee Associates Share Their Success

By JAMES A. GIBBS, AAPG Foundation Chair

The AAPG Foundation's Trustee Associates are looking for some new members – and for a limited time, joining this terrific and important group is easier than ever.

The Trustee Associates is the group the Foundation looks to as its backbone of financial support. In Fiscal Year 2015, Trustee Associates members contributed 57 percent of the almost $1 million received as new contributions to the Foundation.

The group has a proud and glorious history that started in 1976, 10 years after the AAPG Foundation's founding, when Dean McGee, then-chairman of the Trustees, suggested creating a support organization.

The members would meet annually, he said, provide input into Foundation affairs, sponsor projects and enjoy social activities.

The Trustee Associates program was designed to raise money to permit the Foundation to pursue its goals and objectives, provide recognition to donors and, through its leadership, give advice and counsel to the members of the Board of Trustees.

The group's first meeting was held May 20, 1978, at Shangri-La, Okla., following the dedication of the Weeks Energy Resources Tower in Tulsa. Thirty-one Trustee Associates attended. Total membership then was 67 and the required contribution was $2,500. Each year since, Trustee Associates have met together in resort locations for several days of discussions, recreation and social activities.

The AAPG Foundation Trustee Associates during their gathering in Hawaii.

Trustee Associates Today

Through the years, generous gifts from the Trustee Associates, as well as from many other members and friends of the AAPG, have added to the Foundation's permanently endowed corpus, and today the Foundation's total assets are almost $50 million.

Revenue from its managed investment portfolio, augmented by annual contributions, allows the Foundation to support many worthy programs, activities and services.

As assets of the Foundation have increased, so have the needs of its distributions. The Foundation joins with AAPG in support of "joint programs" deemed to serve both the Members of AAPG and the interests of the general public. These include Grants-in Aid, Imperial Barrel Award and the Distinguished Lecture and Visiting Geoscientists programs.

The Foundation also provides supports to other AAPG programs that meet the public benefit test, like the AAPG Bulletin through the Pratt Bulletin Fund, as well as operating its own programs, including the Military Veterans Scholarship and L. Austin Weeks Memorial Undergraduate Grants programs and others.

Additionally, the Foundation awards discretionary grants each year to a limited number of organizations and programs, with funds made possible by the L. Austin Weeks Memorial, and General and Education funds. These include Geoscientists Without Borders, a joint program with the SEG and others, the U.S. National Academies, National Research Council and support of several museum projects.

Membership Drive

As recently as 2012 the number of Trustee Associates was almost 300. However, during the last few years, membership has declined about 10 percent, due primarily to members' age and infirmities. We'd like to see membership numbers increase again to about 300.

For the last few years the required contribution for membership has been set at $15,000, payable over a five-year period. However, to encourage new applicants to join – and only until memberships reach 300 – the required contribution has been reduced to $10,000, also payable over five years.

If you'd like more information about the Foundation or the Trustee Associates program, contact longtime Foundation administrative coordinator Tamra Campbell (at tcampbell@aapg.org, or 918-560-2644) for a brochure and application form. She or anyone else on the administrative team will be happy to answer any questions.

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

Foundation Contributions for March 2017

General Fund
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Kate Hadley Baker
Seymour R. Baker
Jacqueline R. Berryman
Kenneth John Bird
John R. Bitler
Jon Frederic Blickwede
Louis Chapman Bortz
Bjorn Kare Bryn
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Grant in memory of John M. and Anne H. Cochrane from the John M. Cochrane Foundation of The Columbus Foundation
ConocoPhillips Corporate Contributions
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Amoruso Special Publications Fund
Richard Steinmetz

Awards Fund
Teacher of the Year Award
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Digital Products Fund
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L. Austin Weeks Undergraduate Fund
Andrew L. Brill
Marta S. Weeks-Wulf
In memory of Austin Weeks

DIRECTOR'S CORNER

It's Time to Get Exploring

By DAVID CURTISS

Celebrating the past is an important aspect of our 100th anniversary and featured prominently at the Annual Convention and Exhibition (ACE). From a full-day event on pioneering women in geoscience, to the special History of Petroleum Geology session, to an inspirational talk inspired by Wallace Pratt and presented by an Erick Devine, an actor, portraying him at the Division of Professional Affairs luncheon, the nearly 7,800 attendees at ACE were reminded at every turn of the legacy of our profession. We truly stand on the shoulders of giants.

But as we look ahead to the rest of 2017 and beyond, our focus must be on the future.

There are many looming questions for our profession, from the evolving role of geoscience in conventional and unconventional exploration and production to how alternative energy sources will affect global energy markets in the years and decades ahead.


CURTISS

> Our job at AAPG is not to predict the markets ... our principal responsibility is to help you more effectively find oil and natural gas, whether that is in short-term or long-term projects.

Not a Swing Producer

CERAWeek is an annual event presented by IHS Markit (parent company of Cambridge Energy Research Associates, for which the event is named) and hosted by Dan Yergin, who spoke at the centennial gala at ACE. Known as the "Davos of energy" it serves as a hub for energy ministers and CEOs from across the globe to gather and talk.

One of the principal discussion topics this year was how unconventional resources were affecting energy markets.

I've heard people suggest that U.S. shale producers are the new swing producers in the market, bringing the marginal barrel of oil to the markets. But that's not how market experts see it. They differentiate between swing producers, short cycle time projects, and long cycle time projects.

The swing producer is one who has excess production sitting behind the valve. And that resource can come to market quickly and easily with a simple twist of the valve. Saudi Arabia still dominates this role on a global basis. Surely other producers occasionally have excess production, but on a consistent basis it is Saudi Arabia that plays this role in world markets.

Short cycle time projects, in contrast, might take anywhere from six to 12 months to deliver first oil to market. This is where small conventional exploration and most unconventional resource development takes place. Shale producers can quickly bring new supplies to market, and they are filling an important and growing space in the oil and gas markets portfolio. At times they can nearly be swing producers.

That leaves the long cycle time projects: the massive, complex operations that take five to 10 years to fully develop and deploy. Typically large discrete oil and gas reservoirs, these developments are the engineering and commercial marvels that most of the public thinks about when it thinks of "Big Oil."

Reading the Signals

Each of these project types has unique opportunities and challenges of its own. Each contributes in its own way to supplying oil markets and, historically, the natural boom and bust cycles that characterize commodity markets have sent appropriate signals to oil and natural gas producers to invest in the types of projects that will best position them to meet expected demand.

The current oil and natural gas prices have been sending signals to producers resulting in underinvestment, which sets the stage for another future price shock. And, this had some presenters at CERAWeek fretting earlier this year. Fatih Birol, executive director of the International Energy Agency, and Mohammed Barkindo, secretary general of OPEC, both warned that the cutback in investments during the current downturn – while understandable – would put pressure on future supply even as demand continues to grow.

Our job at AAPG is not to predict the markets, though each of us in this profession needs to understand that we're operating within these markets. But our principal responsibility is to help you more effectively find oil and natural gas, whether that is in short-term or long-term projects.

And in the next 90 days we're presenting you two opportunities to do just that.

This month of the Offshore Technology Conference (OTC) convenes in Houston. Thanks to the efforts of AAPG Members on the AAPG subcommittee, led by Buford Pollett and Eric Cauquil, who each year work to develop a strong geoscience technical program. They've done it again this year, and I encourage you to attend OTC, visit the technical sessions, and the exhibition.

The second opportunity is in July when we will launch the 2017 edition of the Unconventional Resources Technology Conference (URTeC) in Austin, Texas. Much like OTC, this multidisciplinary conference for geoscientists and engineers is dedicated to advancing the science of unconventional resources.

Whether you're pursuing long cycle time or short cycle time projects, it's time to get exploring.

DIVISIONS REPORT: EMD

Excitement for the Next 100 Years

By ANNE DRAUCKER, EMD President

Having just returned from a fantastic Annual Convention and Exhibition in Houston, to celebrate the 100th anniversary of AAPG, I'm feeling very encouraged about the future of our Association.

One of the highlights for me was the opportunity to present on the state of the Energy Minerals Division to the AAPG House of Delegates.

Our EMD membership currently stands at 3,262 paid members, and an additional 662 unpaid members. If you'll recall, membership in EMD is free with AAPG membership: all you have to do is check the box opting in. So those "unpaid" members are either not checking the box when they renew their AAPG membership, or they are not renewing their membership at all. Now, it's certainly not unusual for folks not to renew until the last minute, or even late, but these numbers do reflect a trend in the larger membership body.


DRAUCKER

> I can't think of a better investment of twenty bucks than membership in one's professional society when one is job-hunting.

Gathering the Lost

So, why is this?

Obviously, the downturn has significantly impacted the Association, but it's quite difficult to collect data from people with whom you aren't in contact. Rather than just speculating (I'll do that too, in a minute), let's look at a bit of the data.

One category of non-renewers is "lost Members." These are folks who were sent a renewal form and it came right on back. Their addresses changed and have not been updated in the AAPG system. I like to think they aren't hiding from us, so what probably happened was that they were using their work address for AAPG membership and changed jobs as a result of the current economy. Or, they simply moved or retired.

But you can help. Do you have any friends who might need to update their address? Buddies who just retired? Keep them involved!

Another obvious cause is that people who lost their jobs might not be able to pay the more than $100 to renew. But good news for them as well: AAPG has a graduated dues system. (Visit www.aapg.org/about/membership/graduated-dues.)

They may qualify for income-based reduced dues, as low as $26.25. I can't think of a better investment of twenty bucks than membership in one's professional society when one is job-hunting.

Evolving Into the Future

Now, for some speculation.

Maybe people aren't joining AAPG, or EMD specifically, because they don't perceive any value.

As an invested participant, that's a hard idea for me to digest, but I think it's important to talk about. So, to address that, the officers and councilors of EMD are working hard on better ways of communicating with our members.

Obviously, we're going to keep doing many of the awesome programs we're doing (short courses, talks, posters, all the convention participation, commodity reports), but we're working on finding better ways to communicate the value of those programs.

We're also focusing on building a more interactive community, and providing direct business value both to AAPG and to EMD members.

I'm very excited for what is to come. If I may use a sappy analogy (that's a preemptive pun), sometimes pruning makes the whole tree healthier, even though it hurts. We've all been taking a close look at what we do and why we do it.

This column is for talking about EMD, but rest assured that much more intense, focused and informed work is also going on at all levels of AAPG's organization.

That's why I'm encouraged about the next 100 years. Our emphasis on growing and evolving (even though, sometimes our changes may seem like they're only visible on a geologic time scale), on engaging members and providing value to them, and on adopting and adapting technology, will serve AAPG and EMD well in the future.

Most importantly, the relationships built through our Association are enduring. I'm proud to say I'm an AAPG Member, and many of my closest friends and colleagues are AAPG Members across the world.

I'm honored to have had the opportunity to serve, and I look forward to a lifetime of AAPG membership and volunteering.