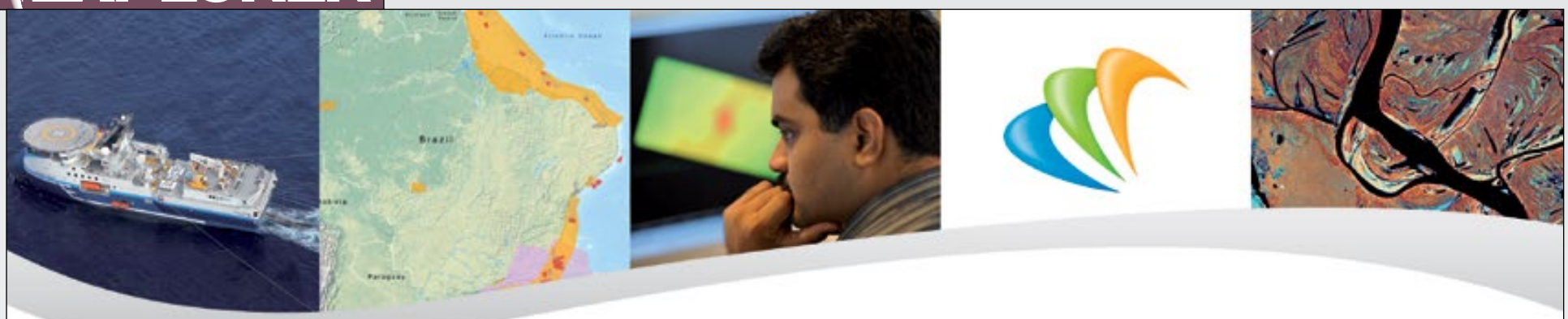
AAPG EXPLORER
SEPTEMBER 2015

Sea of Plenty

Deep action continues in the Gulf of Mexico.

See page 14



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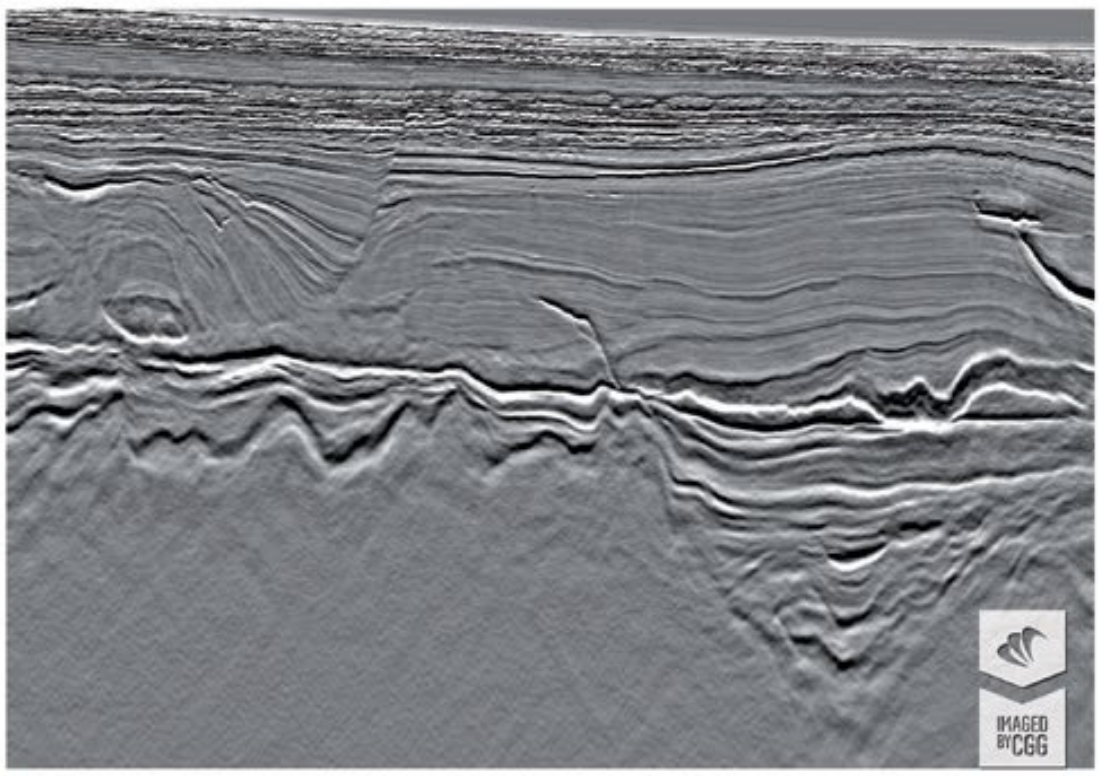

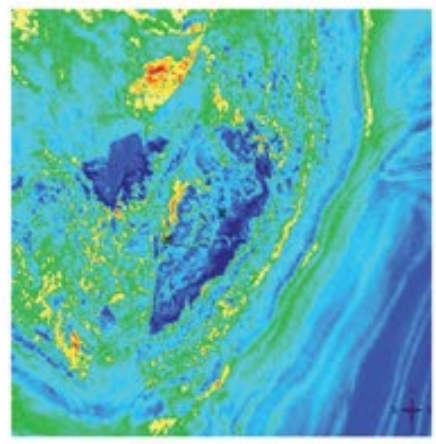

Example of BroadSeis with its advanced subsurface imaging in the Campos Basin, and BroadSeis acoustic inversion in the Santos Basin.

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Vol. 36, No. 9
September 2015

AAPG EXPLORER

PRESIDENT'S COLUMN

TIGs, SIGs and Other Musings …

BY JOHN HOGG

As I write this article, your Executive Committee is meeting in Tulsa to review the 2015-16 business plan, the current long-range plan and receive an update from Past President Lee Krystinik on the 2014-15 Ad-Hoc Committee on Governance, which is expected to report to the Executive Committee in October.

Krystinik's committee of nine includes three members from each of the 2014-15 Executive Committee, Advisory Council and House of Delegates – and their charge was to review the current AAPG governance and provide advice to the Executive Committee on the best type of governance for AAPG going into our second century.

The last significant changes to the Association's Constitution and Bylaws were in 1969-70, under the guidance of then-immediate past president Frank Conselman.

* * *

The first month of my presidency was focused on committee appointments and ensuring all committees include a Young Professional as a chair, vice chair or co-chair.

I have had great support from all of the current or newly appointed chairs on this initiative, and I'm quite confident that this will instate the integration of the Millennial Generation – AAPG's largest demographic group, all born between 1980 and 2000 – into AAPG leadership; after all they are the future of our great Association and they are ready to serve.


HOGG

TIGs and SIGs can be about any technical or non-technical theme or subject matter, and will provide an interested group with flexibility to pursue adding an infinite number of interested members.

My other push in my first month was to work with the staff to build a procedure, initiated by the House of Delegates Resolution Committee on the formation of Technical Interest Groups (TIGs) and Special Interest Groups (SIGs), to allow interested individuals, groups or current committees and Divisions to apply to become a TIG or SIG.

I think this is one of the most exciting initiatives that we have undertaken since the formation of the Regions. It allows for much greater flexibility than a standing committee, which can have a maximum of 10-12 members, and much less bureaucracy than a Division, which has a formal organizational structure and is accountable to both its membership and the Executive Committee.

TIGs and SIGs can be about any technical or non-technical theme or subject matter, and will provide an interested group with flexibility to pursue adding an infinite number of interested members.

This opportunity will be grounded with a new AAPG Web-based infrastructure that will be powerful enough to allow the TIG or SIG to achieve real results, which can be measured in the form of future technical sessions, fellowships, conferences/workshops, publications and other scientific endeavors.

So, if you have a topic that is of burning interest to you, and you find others in AAPG who share your love and passion to discuss, present or publish on those topics, why not look into forming a group?

* * *

I also am attempting to be the first AAPG president to use social media to connect with members.

You may recall in July, I ended my EXPLORER column with "follow me on Twitter @AAPGPresident." Well, if I had done a P_{10}-P_{90} distribution on the number of followers I would have by the end of the month of July, I would have vastly below the low portion of the predicted range (read: a dry hole!).

I had four followers by the end of July, with one being David Curtiss – so really I had three; David is very social media savvy, and for a year I'm his boss, so he made the right decision to follow AAPG President.

Of course, I know the majority of the membership are not social media savvy, due mostly to being part of the Baby Boomer generation – but the vast majority of you have smart phones, and in today's world social media is the way many professionals communicate and stay up to date on what is trending in our industry and our science.

So I'm hopeful that with this reminder, my followers by the end of September will more than double to 10!

* * *

Finally, next month, I'll turn this column over to our Editor, Mike Sweet, to discuss some of the exciting things that AAPG is doing with respect to our flagship publication, the BULLETIN, and upcoming publications.

And again, remember, you can follow me on Twitter, at twitter.com/AAPGPresident.

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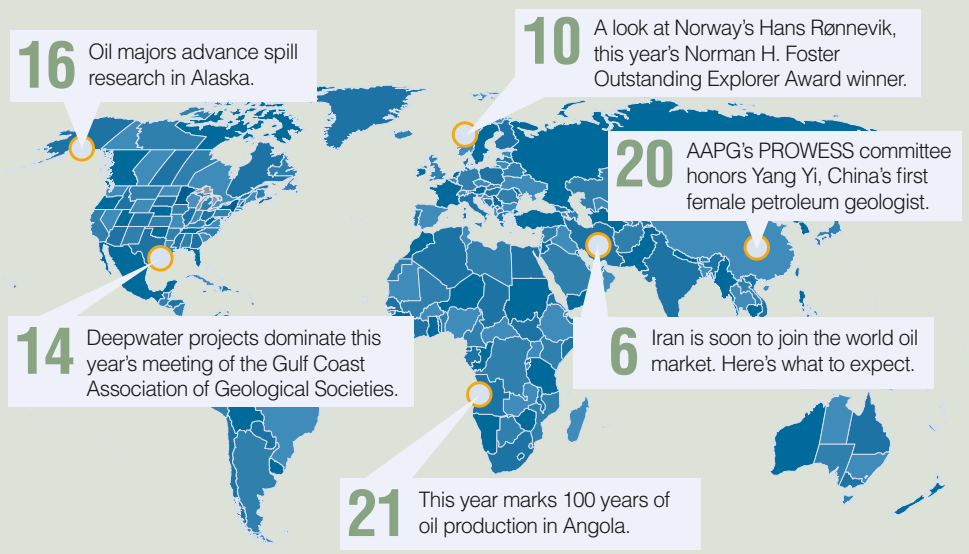

REGULAR DEPARTMENTS

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

ON THE COVER:

The Deepwater Fields Session at this month's GCAGS annual meeting in Houston will include a talk on Shell's Ursa field, where the three drilling platforms pictured here – Olympus, with Mars and Ursa in the background – produce high volumes of oil and gas daily. See story on page 14. Photo courtesy of Shell.

Left: Yang Yi, China's first female petroleum geologist, with colleagues in the field in the 1940s. Photo courtesy of Guonong Hu. See story on page 20.

Vol. 36, No. 9

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Earth Science Week: 'Visualizing Earth Systems'

"Visualizing Earth Systems" is the theme of this year's Earth Science Week, an annual event that promotes scientific understanding of our planet.

This year's event will be held Oct. 11-17 and will promote awareness of the many ways scientists monitor and represent information about Earth systems including land, water, air and living things.

Since its inauguration in October 1998, the mission of Earth Science Week has been to promote the understanding and appreciation of earth science, especially among young people, as each year community groups, educators and interested citizens organize educational and celebratory events around the Earth sciences.

Earth Science Week is organized annually by the American Geosciences Institute (AGI) with support from the AAPG Foundation, U.S. Geological Survey, NASA, U.S. National Park Service, ExxonMobil, ESRI and others.

Earth Science Week 2015 includes three national contests honoring this year's theme. This year's competitions will feature a photography contest, a visual arts contest and an essay contest.

Students, geoscientists and the general public are invited to participate in this year's photography contest, "Earth Systems Interacting." Entries must be composed of original, unpublished material, and show at least one Earth system affecting another Earth system in your community.

This year's visual arts contest, "Picturing Earth Systems," is open to students in grades K-5. The contest calls on students to use artwork to show how land, water, air and living things interact with and affect each other.

Finally, students in grades 6 through 9 may participate in the essay contest. This year's essays must address the idea of "Earth Science Visualization Today" and explain one way in which geoscientists' use of cutting-edge visualization is advancing Earth science today.

Submissions will be judged by a panel of geoscientists on aspects of creativity, relevance and incorporation of the topic at hand. Selected winners will be awarded for their submissions.

For more information, visit EarthSciWeek.org.

Deadline Fast Approaching For ACE Abstracts

The call for abstracts closes Sept. 24 for the AAPG 2016 Annual Convention and Exhibition.

The meeting will be held June 19-22 next year, returning to Calgary, Canada for the first time in 10 years, where it will be held at the BMO Centre at Stampede Park, co-presented by AAPG, the Society for Sedimentary Geology (SEPM) and the Canadian Society of Petroleum Geologists (CSPG).

With a global audience of some 7,000 professionals from more than 72 countries, ACE is one of the most prestigious events for the geosciences community with a tradition of delivering an exceptionally strong, juried technical program, state-of-the-art technology displays and networking activities that create a dependable, fun and valuable business forum.

The call for abstracts seeks presentations to fill 10 themes, as well as two special sessions and poster sessions.

The session themes are:

- Siliciclastics.
- Carbonates and Evaporites.
- Energy and the Environment.
- Geochemistry, Basin Modeling and Petroleum Systems.
- Structure, Tectonics and Geomechanics.
- Unconventional Resources – Continuously Evolving and Expanding What We Know and Exploring What We Don't.
- Oil Sands – Responsibly Exploring and Developing Vast Bitumen Resources.
- Resources to Reserves – Extracting Value Through Innovation and Business Efficiency.
- Geophysics – Integration of Geosciences and Engineering for Exploration and Production Success.
- Redefining Reservoir – Core Values.

Also, there will be AAPG and SEPM student poster sessions focusing on the research and current work of student members.

Additionally, there will be two special sessions, which are as follows:

- SEPM Research Symposium: Revisiting Foreland Basin Tectonics, Stratigraphy, Sedimentology and Drainage Systems.
- History of Petroleum Geology: Remembering the Lessons of the Past: Key People, Key Concepts and Key Events From a Canadian Perspective.

Exhibit space is also available, and in this time of tightened belts, it's as important as ever to take advantage of the far-reaching exposure offered by AAPG's ACE.

To submit an abstract, sign up for exhibit space or get general information, visit ACE.AAPG.org/2016.

AAPG Annual Convention & Exhibition 2016

Is a surge coming?

Outlook for the Post-Iran Sanctions Oil Market

By DAVID BROWN, EXPLORER Correspondent

Still feeling optimistic about the near-term future of oil? Here's something to think about:

When Iran, Iraq and Libya return to their full production potential, the world price of crude oil could fall considerably lower.

Right now most eyes are on Iran.

With a plan in place to phase out international economic and export sanctions against the country, Iranian officials have vowed to raise oil production by at least one million barrels per day (b/d).

Some industry experts think Iran could lift its total oil production to more than five million b/d, up from last year's annual level of over 3.3 million b/d of crude plus liquids.

Will Iran be able to bring substantially higher oil exports to market?

This outlook includes arguments for and against a surge in Iranian production and a resulting drop in world oil prices.

FOR: GEOLOGY

Iran's proved oil reserves of 150 billion to 160 billion barrels is almost 10 percent of the world's total, ranking it fourth in world crude reserves.

Thick deposits on the floor of the ancient ocean Tethys eventually became the world's biggest oil and gas accumulations around the Middle East Gulf. The collision of the Arabian Plate with the central Iranian plateau led to the Zagros Orogeny and created an extensive folded zone.

Those folded structures present excellent traps for oil and gas, and now contain Iran's major oil and gas fields.


MAUGERI

> "Iran may raise its oil production – crude oil and condensate – by around 900,000 barrels per day in just one year."

"Global Resource Assessments from Total Petroleum Systems" (AAPG Memoir 86, 2005) makes it clear just what a monster the Zagros Fold Belt Province is, in the Zagros-Mesopotamian Cretaceous-Tertiary total petroleum system.

That system ranked first in the world in:

- Total estimated oil endowment, with more than 466.7 billion barrels.
- Future oil production – 366.3 billion barrels.
- Mean estimated undiscovered oil – 94.5 billion barrels.

Iran has favorable geology, and a lot of oil.

AGAINST: CAPITAL

Most industry experts agree that it will take at least $30 billion in capital infusion to kick-start Iran's productive capacity.

Iraq faced a similar challenge in rebuilding its oil infrastructure and was able to attract financing and industry participation, but that was at a time of much higher world oil prices and more readily available funding.

How much capital will be available to Iran, and under what terms, remains to be seen.

Leonardo Maugeri, former head of strategy at Eni SpA, is now an associate at Harvard University's Kennedy School in Cambridge, Mass.

Maugeri said in order to exploit its full potential to 2020-22, Iran needs investment of at least $70 billion. But a quick initial boost to production from current levels might not be so expensive, he added.

"Iran may raise its oil production – crude oil and condensate – by around 900,000 barrels per day in just one year, because most of this production capacity was cut off by the most recent sanctions.

"That production increase is not as expensive as many think," Maugeri said. "It only implies spending a few billion dollars."

FOR: OIL IN STORAGE

Iran is believed to be storing up to 40 million barrels of oil, mostly in floating storage on tankers.

When sanctions and export restrictions are lifted, Iran could not only begin marketing more of its excess production but also sell its stored stocks of crude, giving it a quick boost in income.

Edward Morse, global head of commodities research for Citigroup, said Iran's stored crude and condensate could be high in sulfur, and only about one-third of it will create overhang in oil markets.

If the oil is sour it might sell at a steep discount to today's prices.

AGAINST: POLITICAL UNCERTAINTY

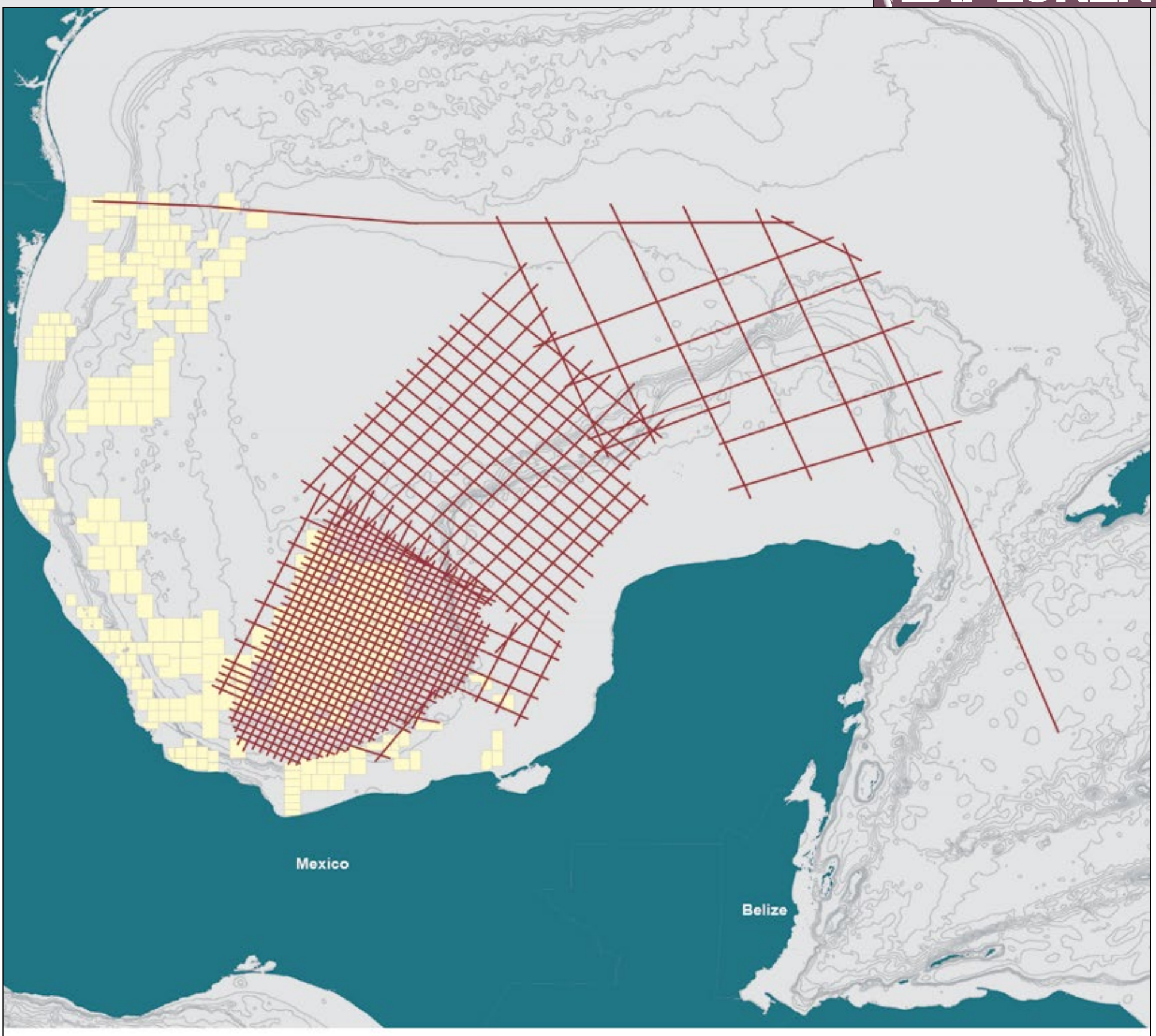
The world's geopolitical situation has not favored Iran.

Even if it gets a best-case nuclear limitation deal, Iran must meet a number of conditions to escape sanctions. And any meaningful violation could bring about a full reinstatement of sanctions under existing agreement terms.

While a great deal has been written about Iranian-Israeli tensions, Tehran is almost 1,000 miles from Jerusalem. Iran is bordered immediately on the east by Afghanistan and on the west by Iraq, and it is within reach of Islamic State turmoil.

Middle East tensions and an unclear path on sanctions may make it difficult for Iran to attract industry participation and to enter into reliable long-term supply arrangements.

See **Access**, page 8



Access
from page 6

FOR: ASSET ACCESS

Economic restrictions and sanctions have cut Iran off from billions of dollars in overseas capital reserves and assets.

Banking compliance with U.S. sanctions has restricted Iran's access to foreign reserves, and many of its overseas assets remain frozen and inaccessible.

The amount of restricted accounts and other assets is disputed. Iran has claimed it will regain access to $30 billion of "usable assets" when sanctions are lifted. Other estimates put Iran's restricted assets at $100 billion or more.

Whatever the final amount, access to previously restricted assets will benefit Iran. The biggest obstacle might be the United States, which fears Iran will use some of the money to fund militant groups.

> "In the medium term, to 2020-22, Iran may produce more than five million barrels per day, and even reach 5.3–5.4 million."

AGAINST: PRODUCTION DECLINES

While Iranian production has been slowed, but not stopped, there's no certainty about the future productive capacity of its fields.

Half of Iran's production comes from oil fields that are more than 70 years old, including Ahwaz-Asmari, Marun and Gachsaran, according to the International Energy Agency.

Almost 80 percent of Iran's existing reserves were discovered before 1965. The U.S. Energy Information Administration estimates that Iranian oil fields have natural decline rates of 8-11 percent.

In much of 1976-77, Iran produced more than six million b/d. Production fell after the 1979 Iranian Revolution, but Iran eventually managed to increase production from two million b/d in 1986 to 4.2 million b/d in 2008.

Then lower oil prices, recession and sanctions cut production again. Following the implementation of new sanctions in 2011-12, Iranian oil production fell from almost 3.7 million b/d in 2011 to 2.7 million b/d in 2013.

According to data from Bloomberg, Iran's recent production has been about 2.8 million b/d. How much Iran can increase production, and how quickly, and how long it can sustain increased production, remain serious questions.

FOR: REDEVELOPMENT

Maugeri believes Iran could increase production to more than five million b/d in the next five to seven years.

"In the medium term, to 2020-22, Iran may produce more than five million b/d, and even reach 5.3-5.4 million b/d, either by developing newly discovered fields or by redeveloping existing fields by raising their current, and modest, recovery ratio," he said.

Iranian officials claim a recovery ratio around 25 percent, compared to a world average of 35 percent, but the reality is that Iran's recovery ratio is no higher than 19 percent, Maugeri said.

"Raising the recovery ratio implies having better technology, better reservoir management capabilities and, of course, money," he noted.

AGAINST: THE USA

Proposals to initiate a nuclear-industry monitoring program and to lift sanctions and export restrictions against Iran continue to generate controversy in the United States.

Six major world powers, the European Union and the United Nations Security Council have agreed to steps that would begin to remove Iranian sanctions in exchange for limits on nuclear development.

Resistance to the agreement, especially by Republicans in the U.S. Congress, could lead to slower implementation of the plan and even secondary sanctions or restrictions, creating a more difficult path for Iran.

FOR: THE USA

Any argument for falling world oil prices from increased Iranian production has to acknowledge the changed role of the United States.

The United States no longer acts as a consumption buffer for increased world oil production, with its past appetite for oil imports. An astounding increase in energy production in North America has made some American producers eager to export crude.

That's a game-changer in the world's ability to absorb excess oil production, especially if China's growth slows, economic problems in Europe persist and the U.S. recovery continues at a modest pace.

BOTTOM LINE

The short-term future of oil might not be the question.

If current production estimates are correct – never a certainty with Iran – an increase of 500,000 b/d would only take Iran back to fairly recent production levels.

A bigger question is whether the country can lift production to four million-plus b/d and then, over the longer term, move toward sustainably producing five million b/d or more in total crude and liquids.

Given the age of most existing major Iranian fields, that could require something that's been scarce in Iran in recent years: Exploration.

Norman H. Foster Outstanding Explorer Award

Rønnevik Champions Exploration in Norway

By HEATHER SAUCIER, EXPLORER Correspondent

When revealing the traits that make an explorer successful, Hans Christen Rønnevik, recipient of this year's Norman H. Foster Outstanding Explorer Award, said it is not necessarily a detailed eye that finds oil and gas.

Rather, a broader view can be advantageous.

"I like to create relationships between various detailed elements in the broadest possible context," he said. "It is important to know what one is 'defocusing' from. The ability to think associatively is also a key factor."

That is the thinking that has led Rønnevik to discoveries in the North Sea that have rivaled some of the most significant discoveries in the world.

One of his finds that has generated ripple effects in his native Norway was made near the Utsira High – one of the largest structural features on the Norwegian Shelf in the North Sea.

Explored by Esso in 1967 with little success, the reservoir eventually was downgraded for exploration by many in the industry, as it could not be imaged with 3-D seismic technology, was associated with basement erosion, fractured and weathered basement, and in independent sedimentary cover.

The reservoir remained unexplored for 30 years until Rønnevik, working as exploration manager for Lundin Norway, developed a play that led to the discovery of billions of barrels of oil during a time when it was believed that only small fields remained in the North Sea.

Photos courtesy of Hans Rønnevik

Rønnevik with colleagues on the North Sea.

In 2007, near the Utsira High, Rønnevik discovered the Edvard Grieg and Edvard South fields, totaling nearly 200 million barrels of oil.

In 2010 he discovered the giant Johan Sverdrup Field, totaling 1.9 to 2.9 billion barrels of oil.

In 2013 he discovered the Luno II Field, totaling 120 million barrels of oil.

"He was able to put together the acreage in an area he considered mature and work out the petroleum system story and geology of the Utsira High," said AAPG Honorary member Charles Sternbach, president of Star Creek Energy Company and founder and chair of the AAPG Discovery Thinking forum.

"Hans excels as an explorer because he is an iterative learner," Sternbach said. "He sees the big picture. By holistic thinking, he examines the entire petroleum system.

"And," he continued, "he brings in people of various disciplines to get many views on the same problem, thereby effectively magnifying the collective intelligence to turn an exploration problem into an opportunity."

So noteworthy are his accomplishments that Rønnevik is the first non-North American to receive the Outstanding Explorer Award.

"It is an honor to be appreciated for work over time," Rønnevik said, "and especially work in the last decade."

Loyalty to a Nation

Throughout his career, Rønnevik has worked to keep Norway a fierce competitor in the oil and gas industry.

He began his career as a geologist in the oil office of Norway's Ministry of Industry and Craft before quickly moving to the newly established Norwegian Petroleum Directorate (NPD). There, Rønnevik began mapping the resource potential of the Norwegian Continental Shelf and formulating national exploration strategies.

He also was involved in the geophysical and geological mapping of the Norwegian Sea and Barents Sea.

One of his final tasks at the NPD laid the foundation for a career in mind-bending discoveries: interpreting Block PL089 in the southern Snorre Field –

See **Snorre Field**, page 12

Rønnevik during his time with Lundin Norway.

Snorre Field

from page 10

located in the Tampen area of the North Sea – and writing a detailed drilling work program for its licenses.

In 1984, Rønnevik joined Saga Petroleum ASA, a Norwegian upstream petroleum company eventually acquired by Norsk Hydro, as vice president for exploration. There, he took part in the delineation of the Snorre Field, which is expected to produce reserves greater than 1.4 billion barrels of oil.

Additional exploration of the Snorre Field led to Rønnevik's discovery of four additional fields:

- The Vigdis, in 1986.
- The Tordis, in 1987.
- The Borg, in 1987.
- Tordis East, in 1993.

He also discovered the Laverans Field in 1994 and Kristin Field in 1996. He called these discoveries "impossible" breakthroughs similar to the Grieg and Sverdrup fields.

In 2000, Rønnevik joined Det Norske Oljeselskap, Norway's first independent oil company to become approved as an operator on the Norwegian Shelf. As exploration manager, he helped revitalize the company. It was later acquired by Lundin Petroleum, where Rønnevik continued to work as exploration manager for the startup company, Lundin Norway.

There, Rønnevik oversaw the discovery of the Alvheim Field, with recoverable reserves estimated to be in the 300 million barrels of oil equivalent range – as well as the historical discoveries in the Grieg and Sverdrup fields.

To help his country rise to the top in terms of discoveries, Rønnevik has "founded and nurtured" many exploration teams as well as defined national policies that have led to the creation of tremendous wealth for the nation, said AAPG member Andrew Hurst, professor of Production Geoscience at the University of Aberdeen in Scotland.

"In his career, Hans Christen has successfully served the interests of Norway and then created wealth in small, independent companies in the Norwegian environment, which, until recently, was dominated by large, multi-national corporations," Hurst said.

"His achievements in terms of reserves speak for themselves."

To Rønnevik, "Diversity, and not more of the same, is important for any creative process." He believes that the "truths" of the Earth do not unfold through a "majority" or an "authority."

"Smaller companies focus on the purpose," he added, "and have the will, skill and dedication to achieve it."

Encouraging the Explorer

The theme of diversity is carried into Rønnevik's hand-picked exploration teams as well. He gives the explorers he mentors the freedom to pursue their own interests and ideas – within the purpose of their teams.

"Hans Christen encourages the very best to work with him and share ideas and concepts, thus engendering remarkable exploration environments around him," Hurst said. "Only those who work with him can really know and understand the true value of his leadership and skill."

While at Saga, Rønnevik required four out of every five exploration wells to test new exploration concepts to keep creativity flowing.

"Balanced exploration between frontier, growth, mature and step-out drilling is necessary for continuity," Rønnevik said. "In order to have stability, it is necessary to have a continuous renewal of concepts."

When asked about the old industry adage by the late geologist Parke Dickey, which suggests that the world is not running out of hydrocarbons but rather new ideas to discover them, Rønnevik whole-heartedly agreed.

"The main obstacle for gaining new knowledge is the human mind looking inward and not outward," he said. "Knowledge must be based (on) – but not limited by – facts."

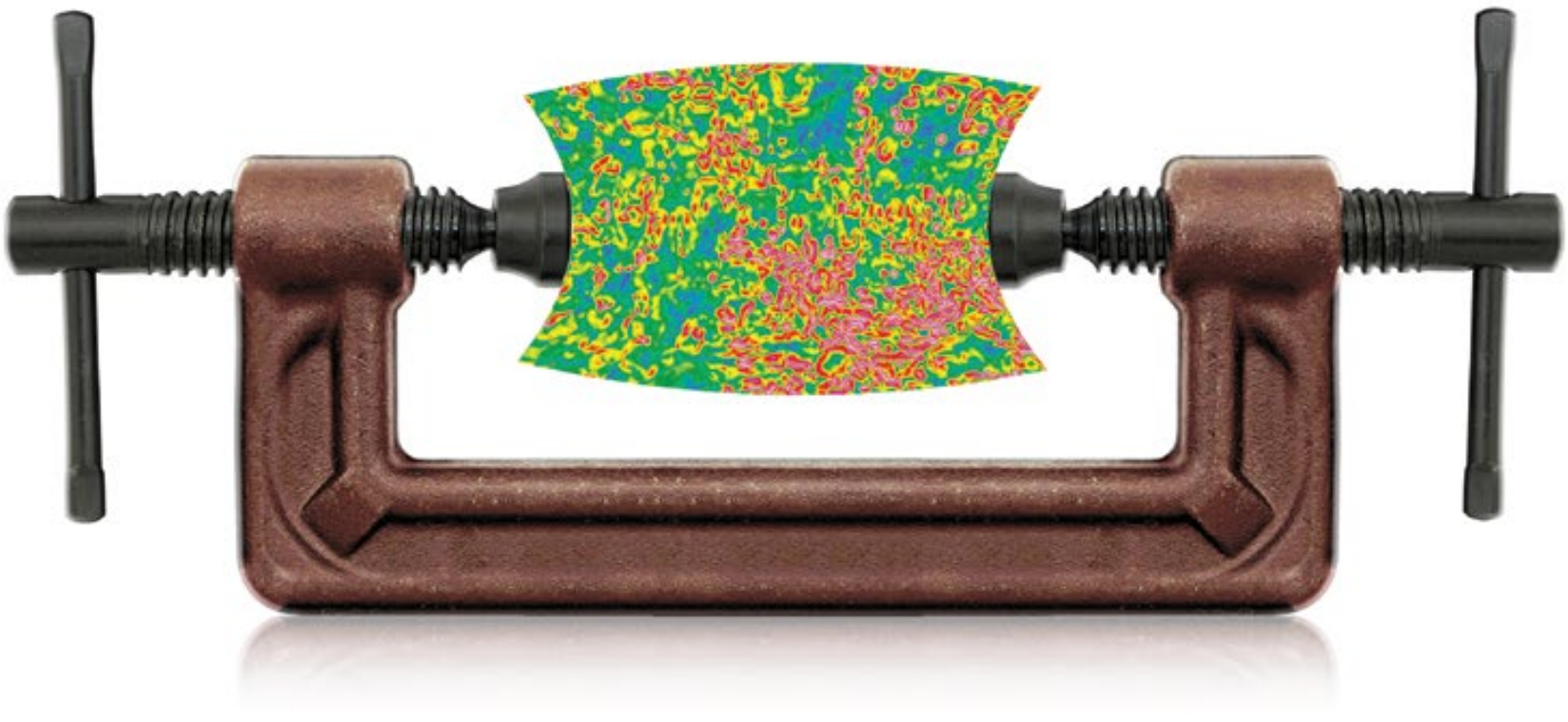
During the past two years, Rønnevik has continued to guide Lundin Norway's exploration in the Barents Sea, where the Alta and Gohta carbonate discoveries were made.

"Hans modestly claimed that he wasn't alone in the Lundin exploration efforts," Sternbach said. "But Andrew Hurst, who knows Hans well, says that Hans has been, and was in this case, the prime prospect generator for Lundin."

(While Rønnevik may be modest about his success, he accepted an invitation to discuss in detail his discovery of the Grieg and Sverdrup fields at last year's Discovery Thinking forum in Houston. His presentation can be found at: http://aapg.to/vid2014Ronnevik.)

"The aspect of continuously learning in light of new data and technology," Rønnevik said, "is the key attraction to exploration."

Squeeze the Most Out of Your Existing Data



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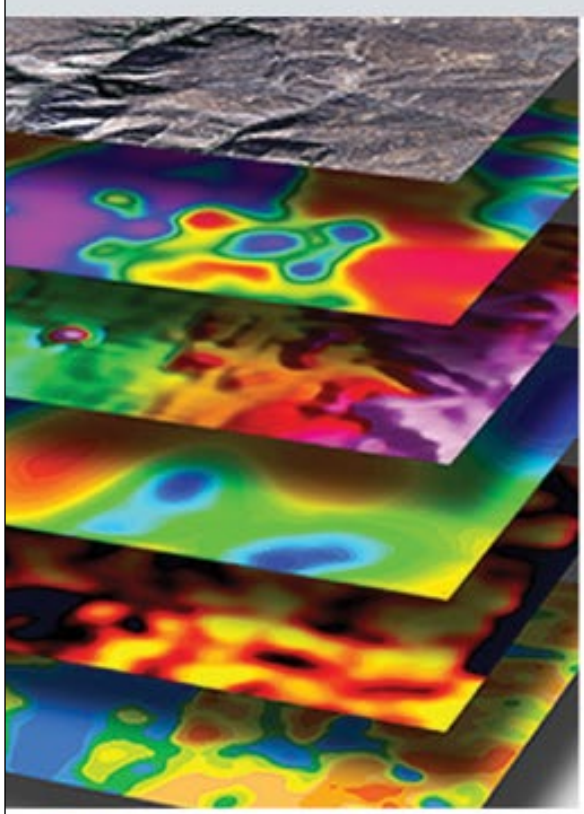

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GCAGS 2015: Deepwater Projects Abound in GOM

By LOUISE S. DURHAM, EXPLORER Correspondent

When it comes to staying power in the U.S. oil game, the Gulf of Mexico takes the prize after producing copious volumes of hydrocarbons for decades, beginning with wells drilled in only a few feet of water.

Today, it's increasingly common to see drill holes punched in water depths of several thousands of feet.

Onshore, the myriad and comparatively inexpensive shale-focused wells have many operators struggling for their financial lives as oil prices continue to fall.

Yet the pricey action in the many challenging GOM deepwater fields goes on unabated, for the most part.


MOORE

> "Explorers have always known the Gulf of Mexico to be a world class exploration basin with tremendous potential."

The timeline for these usually huge finds can easily stretch out for almost a decade from prospect status to production. This means these efforts aren't based on the "high today/low tomorrow" commodity price cycles. Plus, the long-term projects ordinarily have the huge reserves base needed for years-long production, once they come online.

Ongoing advances in technology to increase efficiency while lowering costs also play a key role in this region's activity.

It's only fitting, then, that an entire day at the upcoming 2015 annual convention of the Gulf Coast Association of Geological Societies in Houston will focus on the deepwater Gulf action.

The morning and afternoon sessions together feature a stellar array of 11 deepwater projects, including such heavy hitters as Shell's Appomattox development, Chevron's Tahiti, BP's Mad Dog and Petrobras' activity in the Chinook and Cascade fields.

The All-Convention Luncheon presentation is a not-to-be-missed opportunity to get up to speed on the deepwater environment.

Dubbed "Chevron's Key Discoveries and Development in the Deepwater Gulf of Mexico, A Story of Steady Growth," it promises to provide an intriguing tale of the company's numerous successful efforts in this locale.

The presentation will be delivered by Ken Eisenmenger, deepwater general manager of Chevron North America Exploration and Production Company.

Among Chevron's other Gulf success stories, he will highlight the recent Jack/St. Malo development as an example of overcoming the challenges and delivering a world-class project in the subsalt Lower Tertiary Trend.

Worth Its Salt

Sub-salt is essentially synonymous with deepwater GOM activity today.

It wasn't always this way.

"During the first 40 years of offshore GOM industry exploration, all petroleum reservoir objectives were suprasalt, or above all sheets or beds of salt," said AAPG member Clint Moore, vice president at GulfSlope Energy.

Moore conceived and developed the daylong event for GCAGS and will represent his company on the program, discussing potential oil and gas fields for deepwater slope sands and reservoirs.

As Gulf exploration and research evolved over time, the region's many massive horizontal, allochthonous salt sheets originating from Jurassic salt were determined to cover thick, untested sedimentary sections containing reservoir quality sand bodies and effective sealing shales, Moore explained.

Drilling through these salt sheets is sometimes a big challenge, particularly when it comes to subsalt pressures. Obtaining and interpreting clear seismic data is a story on its own.

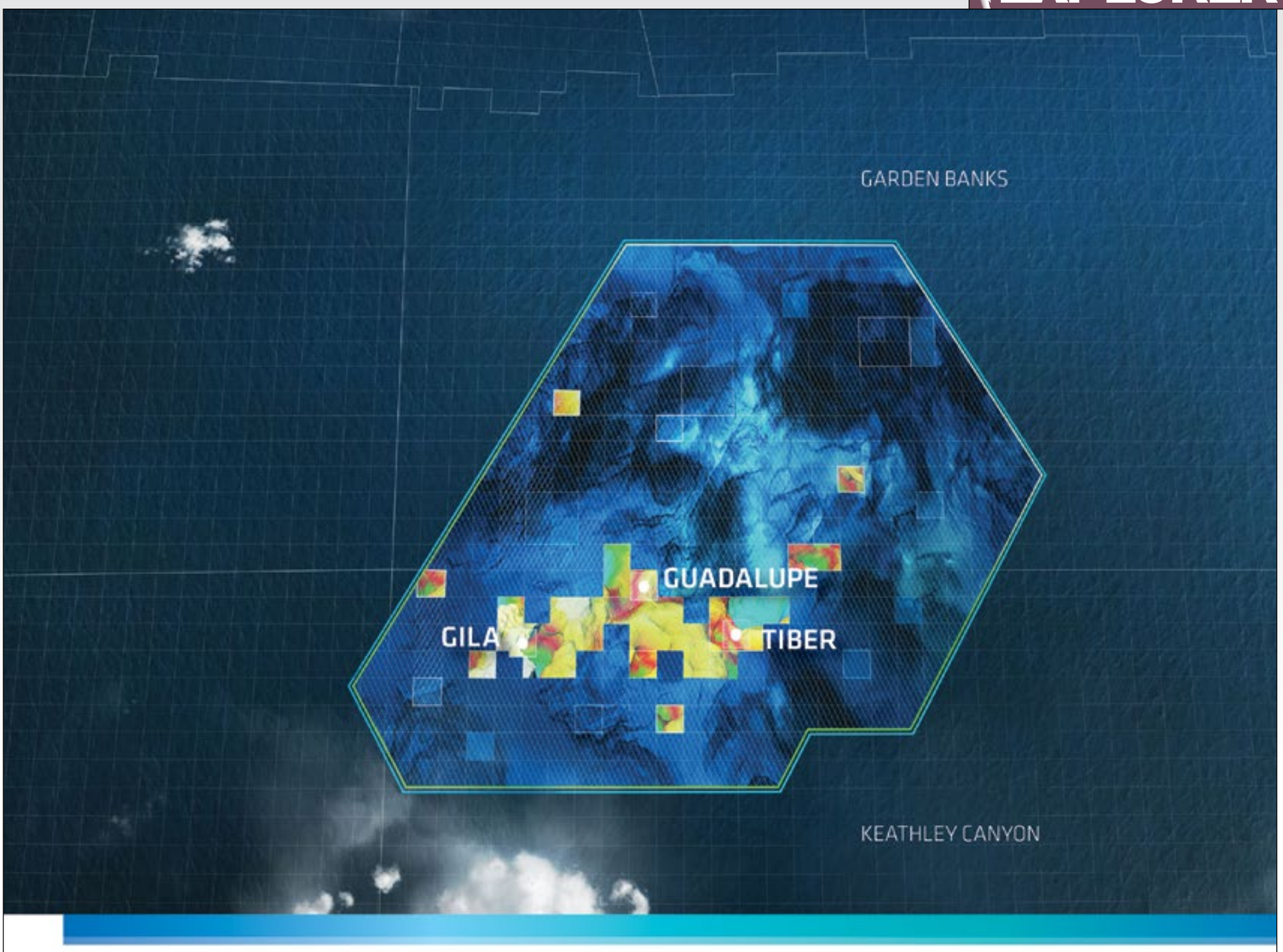
The potential for tapping into huge reserves trapped in the underlying sediments makes these areas worth the risk and the price, though.

"Explorers have always known the Gulf of Mexico to be a world class exploration basin," Moore said, "with tremendous potential."

Dead Wrong About the 'Dead Sea'

In times of industry downturns and well mishaps, the Gulf was often derided as the "dead sea."

See **GOM Potential**, page 22



Oil Giants Join Forces For Spill Response Research

By HEATHER SAUCIER, EXPLORER Correspondent

The oil and gas industry, like any competitive industry, keeps technological advancements close to the vest. The greatest exception to that rule are advancements that promote safety and protect the environment.

After all, one oil spill in any part of the world can bring all operators to a grinding halt.

As sea ice in the Arctic continues to melt, larger windows are opening for exploration. With particular interest in the Beaufort and Chukchi seas, which are carefully monitored by the U.S. government, international operators are coming together to improve oil spill response technology in unprecedented ways.

One includes a recent oil spill experiment just outside Fairbanks, Alaska.

Although the results are still under analysis, it is looking as if a step change might occur in the oil spill response and recovery realm of the industry.

Photos courtesy of the Arctic JIP

The Arctic JIP experiments with herders and burning in a massive tank at the Poker Flat Research Range.

United For a Cause

To ensure the most effective use of resources, funding and expertise, nine international oil and gas companies came together in 2012 to form the Arctic Oil Spill Response Technology Joint Industry Program – known, in short, as the Arctic JIP.

Its members, who include BP, Chevron, ConocoPhillips, ENI, ExxonMobil, Shell, Statoil, North Caspian Operating Company and Total, share the goal of advancing oil spill response technologies and methodologies in the Arctic and other ice-covered environments.

"Environmental issues are a topic that everyone in the industry cooperates on because one spill affects us all," said Joe Mullin, a retired oceanographer and program manager for the Arctic JIP who has conducted research on oil spill recovery for 36 years. "The industry wants to ensure it is prepared to respond and handle any incident that might occur. However, prevention is the highest priority."

Areas of focus for the Arctic JIP include improving the capability of dispersants, in-situ burning, mechanical recovery, remote sensing and trajectory modeling, as well as gaining a better understanding of the environmental effects that could occur from a spill – and the response activities that follow.

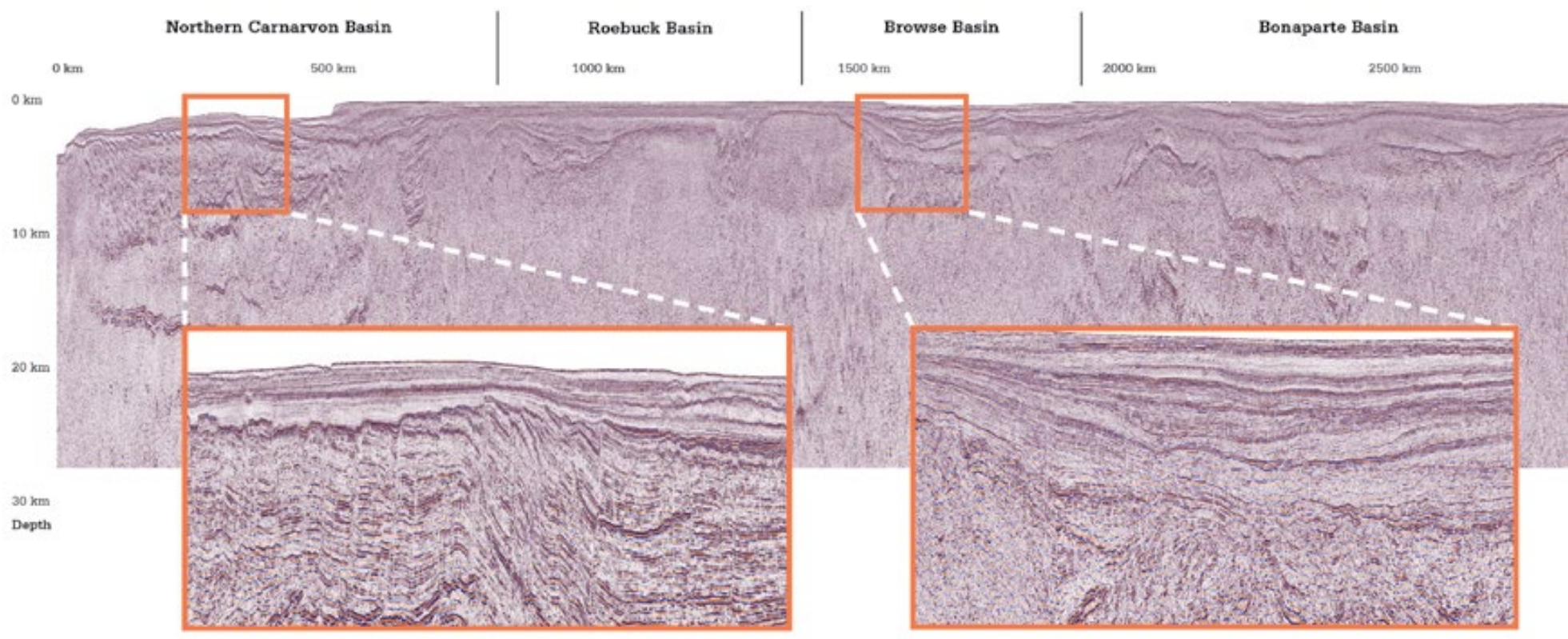
Of utmost importance is enhancing the effectiveness of "herders," which are a type of chemical surfactant (which lowers the surface tension between two liquids – much like dish detergent), in the Arctic environment, and advancing in-situ burning strategies when herders are applied.

Big Ideas, Big Tank

When sprayed around the boundary of an oil slick, a herder can cause oil to contract to a new, thicker equilibrium state. An increase in thickness provides favorable conditions for effective, in-situ burning without the need for containment booms.

Continued on next page

Expanded insight into Northwest Australia an



Continuous 3,500 km line from the Northern Carnarvon Basin in the south to the Aru Trough in the north

Continued from previous page

Containment booms are not ideal for the Arctic, Mullin explained, because it takes time to transport them to remote locations, and the booms tend to gather ice, impeding the oil-gathering process.

Although herders have been studied for years, they have not always been ideal for oil spill response, as some of the early herders were potentially toxic to the environment, he said.

However, two relatively new herders have been approved for use by the Environmental Protection Agency in North America, and the JIP wanted to test their effectiveness in the Arctic environment.

While herders have been tested in the past in large tanks around the globe - the largest one being the size of two football fields – an even larger tank was needed to perform the Arctic-based experiment.

That need led the JIP to contract with SL Ross Environmental Research Ltd. of Ottawa, Canada, which then partnered with the University of Alaska-Fairbanks to design, construct and implement an oil spill and recovery simulation.

The experiment used manned and, for the first time ever, remote-control helicopters to apply herders and ignite oil slicks in one seamless operation.

There were important onlookers for part of the simulation that took place in late April, including representatives from the U.S. Bureau of Safety and Environmental Enforcement, the U.S. Fish and Wildlife Service, the Alaska Department of Environmental Conservation, and Alaska Clean Seas, to name a few.

All were curious to see if the industry had mastered a more effective and safer way to respond to oil spills in the Arctic.

Simulating the Arctic Environment

To conduct the experiment, a 300- by 300-foot tank with an impermeable liner and three-foot gravel berm was constructed last September. It is located at the Poker Flat Research Range, which is a launch facility and rocket range for sounding rockets. Owned and operated by the University of Alaska – Fairbanks' Geophysical Institute, it is one of three locations in the United States approved by the Federal Aviation Authority to test drones.

The tank's size was important, as the Arctic JIP needed sufficient area to release enough oil to simulate a spill and to provide enough maneuvering room for manned and remote-control helicopters to safely spray herders and ignite oil slicks.

Roughly 10 percent of the tank had to be filled with ice to simulate the Arctic's floating sea ice – and this was no easy feat.

"You can't just go to the 7-Eleven and get ice," Mullin said.

Rather, containers of various sizes, including swimming pools and man-made crates, were filled with water and left to freeze. Some ice blocks were 11 feet tall and wide and four feet thick. To avoid having the ice floes drift and accumulate on one side of the tank, the water depth was kept at approximately 10 inches so the ice would remain in place.

A square enclosure was constructed in the center of the tank to hold 26 to 53 gallons of oil. When it was time to create a spill, a wire connected to the enclosure was pulled, and oil quickly spread across the water.

See **Helitorch**, page 18

Members of the Arctic JIP research team discuss the plan for the burn experiment.

The impermeable liner is spread for construction of the tank.

The Bell 407 helicopter used in the experiment.

Helitorch

from page 17

Spraying, Burning … and Results

A Bell 407 helicopter, based in Fairbanks, was fitted with a custom herder tank, pump and retractable hose reel with spray nozzles.

When applying the herders, the hose was let out 120 to 200 feet beneath the helicopter. The helicopter then flew around the oil slick about 40 feet above the water's surface.

As the oil contracted, the helicopter landed and retrieved a Helitorch, which was used to ignite the oil approximately six minutes later using gelled fuel from a 45-gallon tank. The tank was mounted on the Helitorch frame hanging from a freight hook on the belly of the helicopter. (The Helitorch was invented about 40 years ago for the U.S. Forest Service and is routinely used for fire control purposes.)

The first two tests in the manned helicopter used 26 gallons of oil, and the remaining three tests used 53 gallons. In each test, approximately 95 percent of the oil was effectively burned, said David Dickins, chair of the Field Research Technology Working Group (TWG) for the JIP.

Dickins, who works for Chevron's Arctic Center, has researched the subject of oil spills in ice since 1974.

Early results show that one herder, a silicone-based product called Siltech OP-40, has a potentially broader operating window, as it is not highly sensitive to sub-freezing temperatures, Dickins said. The second herder, called ThickSlick 6535, needs to be applied at or above freezing temperatures.

Both products, however, produced the desired effect: rapidly thickening the oil to a minimum of three millimeters.

Residue from each test was collected, and the results are currently being assessed to determine exactly how effective the herders and in-situ burning techniques were.

In a companion project, the Arctic JIP also is studying the ultimate effects of the herders in terms of their ability to biodegrade, to burn off during the igniting process, or to disperse naturally into the water column, Mullin said.

Unfortunately, the helicopter that was equipped for the unmanned part of the experiment suffered an electrical malfunction that took several days to repair. It was eventually able to spray the herders and ignite the oil, but not during the same test.

"Technically it's possible, but there were just a few glitches," Dickins said.

"The manned system worked perfectly, though," he added. "This is the first time we have applied herders around a free-floating oil slick using equipment on a helicopter and then subsequently burned it."

On the Horizon

The initial motivation behind the "herd and burn" system was to create a rapid response tool for remote areas to avoid relying on relatively slow moving vessels. Not only would such a tool expedite an oil recovery response, it would improve safety conditions for the people running the operation.

"We need a rapid response tool without relying on resources from the ground," Dickins said. "We need a response tool that totally delivers from the air, so we have no one exposed to often severe working conditions on the deck at sea."

Furthermore, if herder application and in-situ burning can be performed by a remote-control helicopter, rather than using a pilot, then the safety of an oil removal operation is further enhanced, Dickins explained.

A fully operational system will require that the helicopter, remote or manned, applies the herder and ignites the oil slick in a single flight – rather than having to return to the ground to retrieve a Helitorch or ignition device.

"In real life, a helicopter far offshore can't easily go back and land and exchange equipment," Dickins said. "We need a helicopter that can combine both functions: applying the herder and then igniting it right away.

"We think it's technically doable," he added. "We hope to show this within the next year."

Yang Yi

PROWESS Honors China's First Female Geologist

By HEATHER SAUCIER, EXPLORER Correspondent

Leading up to AAPG's centennial in 2017, the Professional Women in Earth Sciences' (PROWESS) Pioneer Women committee has been researching the nation's first female petroleum geologists, focusing primarily on the AAPG's earliest members and publishing their biographies in the EXPLORER.

Along the way, the PROWESS committee has broadened its scope to include geologists from other countries. In doing so, they stumbled upon an eye-catching fact: Women in the United States became petroleum geologists much earlier than women in other countries – most likely because of freedoms and cultural dynamics so powerfully associated with America.

AAPG can trace its first woman member back to 1918, whereas in other countries, women began studying and practicing geology decades later.

China is one of those countries. The PROWESS committee recently discovered China's first female petroleum geologist, Yang Yi, who began studying geology in the 1940s.

Although Yang is now 93 and unable to recall much of her life because of Alzheimer's disease, her husband and daughter sat down with Chinese petroleum historian Ma Zhen last year to tell her story. Her husband died shortly after the interview.

AAPG member Guonong Hu, a project geological adviser at Anadarko Petroleum, found Ma's article in July and translated it for the PROWESS committee.

"There are very few articles written about Chinese geologists in the West," Hu said. "But if you look at their lives, they have the same kind of dedication to the science as people from any other country. Yang is remarkable, because not only is she China's first female petroleum geologist, she is the first female geologist."

Yang defied her parents' wishes to join the family business and ran away to escape the Japanese occupation of China and to attend one of few elite colleges that would teach women geology. She endured imprisonment and bombings to pursue her degree and perform fieldwork, which would eventually open up one of China's earliest oil fields – only to have her career cut short by the Anti-Rightist Movement in 1957 and the subsequent Cultural Revolution of 1966.

"Her story touched me greatly," said past AAPG president Robbie Gries, president of Priority Oil and Gas in Denver, "not only because she endured the Cultural Revolution, but the fact that she struggled just to get a geology degree. I can't think of any women in the United States who have had that kind of challenge."

* * *

The following biography of Yang Yi is adapted from an April 18, 2014 article by Ma Zhen titled, "China's First Female Petroleum Explorationist – Yang Yi."

Born into a relatively wealthy family in 1920 in Anxin, in the Hebei Province of northern China, Yang Yi enjoyed comforts that many of her peers did not. When her family moved to Beijing she took martial arts classes as a teenager and watched her siblings – one by one – join the family's well-known textile business.

Described as "tenacious" and having a "rebellious spirit," Yang longed for a more independent life.

Photos courtesy of Guonong Hu

Yang Yi with three of her colleagues doing fieldwork in the 1940s.

Japan's occupation of parts of China, including its coastal areas, in 1937 became the catalyst for Yang's desire to move away from home. So did news of a university opening in Kunming in the Yunnan Province in south China, which was still under Chinese control.

The National Southwestern Associated University opened its doors in 1937 as a temporary school that merged the nation's most elite academic institutions, including Peking, Tsinghua and Nankai universities, which were then located in areas occupied by the Japanese.

Lying to her mother, Yang left home and sought aid from the French embassy to buy a boat ticket to Vietnam, a viable detour to Kunming. Nabbed by Japanese military police before she could escape, she was whipped, tortured and imprisoned – only to be released after her family paid a bribe.

Fearing that the stunt Yang pulled – combined with her brother's involvement with an anti-Japanese organization – would cast more vigilant eyes on their family, Yang's parents moved the family to Shanghai for a more low-key existence. Yang remained in Beijing long enough to complete her senior year of high school and receive her diploma before heading to Shanghai.

However, she remained determined to attend Southwestern Associated, but her application materials arrived too late. Instead, she applied to an agricultural school in Yunnan and was accepted. Yang left Shanghai not knowing that would be the last time she would see her beloved mother, who later died of unreported causes.

Yang boarded a ship to Haiphong, Vietnam, and traveled from Haiphong to Hanoi, and then to Hekou, China before arriving in Kunming.

Upon arrival in 1940, "She was in tears because she was finally out of the devil's shadow," Ma wrote, referring to the Japanese occupation of China.

Geology Bound

Rather than attending the agricultural school, Yang learned that Southwestern Associated was recruiting new students, so she applied and was accepted by the Department of Physics. A year later she transferred to the geology department, determined to work in the field despite the fact that no other female student had taken such a path.

Coincidentally, Yang's future husband, Zhang Jiahuan, transferred to the geology department after his civil engineering courses failed to interest him. The two were paired to perform fieldwork for their senior theses and fell deeply in love as they mapped areas near the village of Kebocun.

After graduation in 1945, the Gobi Desert – home to the promising Yumen Oilfield in the Gansu Province – beckoned. There was a desperate shortage of geologists to work the site.

"Few women chose to study geology. Even fewer chose field investigation in the middle of a wasteland," Ma wrote. But Yang and her new husband grabbed the opportunity. Both believed that if oil could be produced domestically, it could help China defeat the Japanese.

The two rode on the back of a truck from Chongqing in southwestern China to the Yumen Oilfield. Poor roads made the roughly 1,500-mile journey last an entire month. After reaching Lanzhou, the capital of the Gansu Province, both bought old sheepskin coats to keep warm. As the truck moved along slowly, the landscape became more inhospitable – and the weather, worse.

"Bound with love in their hearts and a common ideal, this young couple was full of optimism and pride," Ma wrote.

Eight geology graduates, including Yang and Zhang, were sent to the Yumen Oilfield to work as China's first petroleum geological exploration team. Yang was the only woman. They were led by Sun Jianchu, who discovered the field in 1938 and is considered the earliest pioneer of Chinese petroleum geology.

Life in the Field

The team's first assignment consisted of fieldwork, reviewing geological papers and writing reports. Witnessing her natural love for geology, Sun gave Yang extra guidance in the field.

Ironically, he treated her strictly as well, forbidding her – a serious scientist – to sing Beijing opera when he learned that she performed on a small stage one night at the encouragement of her friends. After that, she never sang again.

In early 1946, the Exploration Department of the Gansu Oilfield Bureau was established in Lanzhou, with Sun as its director. Sun led his team, which included Yang, to conduct detailed fieldwork and structural mapping in areas surrounding the Laojunmiao oil field in the Yumen area of the Gansu Province. This required her to extensively study structure and stratigraphy.

"This was the first time that Yang Yi did real field investigations, realizing her dream to be a geological explorationist," Ma wrote. "Perhaps she did not realize this at the time, but when she traveled through the Gobi wilderness on horseback, Yang Yi made history – she became the first Chinese woman petroleum geologist."

Old and grainy photos show Yang working in a hot field – sometimes during sandstorms – with her hair pulled back in thick braids. At night she slept in a tent where it was not uncommon for the piercing green eyes of wolves to surround her camp. Like her male counterparts, Yang would pick up a gun and shoot when they ventured close enough to become a threat.

Picking Up Speed

After several months of fieldwork, she and her colleagues authored the "Geological Report on the Qingcaowan Structure," a first report of its kind for a new area. It essentially laid the foundation for future exploration work and exploratory wells.

Yang then participated in detailed geological investigations along the northern front of Qilian Mountain and provided a wealth of data that helped develop the Yumen oil field.

In 1947, Yin Zanxun, the director of the paleontology department of the National Geological Survey (also known as the

See **Qilian Mountain**, page 22

Yang Yi then.

Yang Yi now.

GOM Potential
from page 14

Not so, Moore insists.

"In its latest report on future GOM petroleum potential, BOEM reported that the GOM has tremendous recoverable petroleum resources, with over 50 billion boe yet to be discovered," he said. "Much of it will be sub-salt and found in slope-basin floor sand reservoirs.

"The Gulf of Mexico has never been a 'dead sea,'" he exclaimed.

When queried as to why he would take on the huge task of assembling such a profound group of speakers and presentations scheduled for the GCAGS, his enthusiasm was palpable.

"My primary goal in proposing this GOM deepwater fields session in the first place was to create the biggest session ever attempted in GCAGS or AAPG history on what makes offshore GOM deepwater productive fields geologically successful," Moore said.

He emphasized that it's a unique opportunity to spend a day totally immersed in better understanding and comparing the premier deepwater GOM fields of today.

"This will likely be a historic session and benefit everyone that attends it with key geological understandings of how and why the GOM continues to be one of the world's premier oil and gas producing basins," Moore noted.

"By better understanding how and what's been discovered so far," he said, "we can then more successfully explore and discover new giant fields tomorrow."

Qilian Mountain
from page 20

founding father of Chinese paleontology) began collaborating with Yang's team. They studied the fossils of Qilian Mountain to establish formation ages.

"The survey areas were vast and deep into the mountains. The work became hard. Down in the valleys, the weather was dry and hot, but up in the mountaintops, the weather was windy and chilly to the bone," Ma wrote. "They even climbed to the main peak of Qilian Mountain to observe ice bridges."

Studying fossils opened up a natural affinity for paleontology for Yang, who quickly became adept at identifying fossils. Her career began to segue into the fields of stratigraphy and paleontology. In 1948, Yang was sent to Nanjing – the capital of China at the time – to identify large amounts of fossil specimens gathered by her exploration team over the years.

Yet in 1949, the Chinese Civil War interrupted her work, and she was sent to Lanzhou for safety reasons, but not before protecting the team's data and property.

Breaking More Ground

In 1950, Yang was assigned to teach paleontology at Tsinghua University, a comprehensive institute of science and engineering – similar to the Massachusetts Institute of Technology – that was founded in Beijing.

The following year, her former exploration department moved from Lanzhou to Beijing under the Petroleum Administration Bureau of the State Council.

Although Yang was in Beijing, her husband remained in northwest China to continue his exploration efforts. By this time, they had a daughter, whom Yang raised temporarily by herself.

For the first time in China's history, a petroleum engineering department was formed at Tsinghua University in 1952 to help meet the nation's needs for hydrocarbons. A year later, the Beijing Petroleum Institute was founded. A well-known geologist, Zhang Geng, was appointed chair of the institute's Geology Department, and Yang was appointed deputy chair.

"Few women made it to the position of department chair in the extremely hierarchical Chinese academic world," Ma wrote. "In the male-dominated field of geology, what Yang Yi achieved can only be described as groundbreaking."

In 1995, Yang's husband joined her at the Petroleum Institute as a lecturer of physical geology. Having been married 10 years and starting off married life together in a tent, the two finally moved into a house in the nation's capital.

"What did not change was their pursuit of geology. Yang Yi worked tirelessly like a machine every day," Ma wrote, explaining that she helped launch the geology department by compiling teaching materials and conducting scientific research.

End of an Era

Just when the future looked brighter than ever for Yang, China was on the brink of becoming a victim of additional political turmoil with the arrival of the Anti-Rightist Movement in 1957. Along with roughly 300,000 Chinese intellectuals, Yang was convicted as a rightist and prosecuted under Chairman Mao Zedong's Anti-Rightist Movement.

Her scientific career cut short, Yang was relegated to less meaningful work, and her home was raided numerous times. The maps and reports she worked so arduously to compile throughout her career were confiscated.

Although her conviction was overturned in 1979, she was at the age of retirement. However, she still managed to compile and co-author two publications: the "English-Chinese Geology Dictionary" and "English-Chinese Petroleum Dictionary."

Today at 93, she has lost most of her memory to Alzheimer's disease. In an effort to save as many pieces of Yang's life and work as possible, her family and friends rummaged through an old warehouse of confiscated goods from the Cultural Revolution and managed to find a few photos of China's first female geologist.

Unfortunately, none of her scholarly papers remain.

A Powerhouse Emerges: ICE 2015

This year's AAPG-SEG International Conference and Exhibition (ICE) is happening this month, Sept. 13-16 at the Melbourne Convention and Exhibition Centre in Melbourne, Australia.

This issue of the EXPLORER includes coverage of several of the events and presentations being featured at ICE, but we've barely scratched the surface of what's in store as thousands of the world's best and brightest petroleum geologists and industry representatives converge in Melbourne.

This year's theme is "A Powerhouse Emerges: Energy for the Next Fifty Years," and the event boasts more than 600 technical presentations; nine field trips to once-in-a-lifetime locations with world-class geologic formations that are normally inaccessible to the public, but are made available to ICE participants; eight short courses; special sessions and forums; networking and social opportunities, as well as activities for students and YPs.

This year's ICE is the first to be co-presented with the Society of Exploration Geophysicists. As a collaborative event by two of the world's largest and most trusted scientific organizations, ICE 2015 will offer indispensable professional and scientific development opportunities and a wealth of information on ever-changing global developments and discoveries.

Career Services: Leveraging Online Tools

Editor's note: Ogunmola is a member of the AAPG Membership Career Services Committee.

By VICTOR OGUNMOLA

Perhaps you already know about the key importance of LinkedIn to professionals, as members of the Membership Career Services Committee discussed this in the August EXPLORER.

This month we want to dive deeper and offer some tips on how to utilize and leverage various tools and functionalities within LinkedIn to optimize your profile and elevate your visibility far and beyond your immediate network for potential career opportunities.

▸ Optimize your "Account and Settings." You can access this by hovering your cursor on your head shot located at the top right hand side of your LinkedIn page. And then:

✓ Job Posting/Manage: Build a profile for a dream job by completing the Job template. This will enable recruiters to easily match you with relevant job openings.

✓ Privacy and Settings: As an active job seeker, it is important to pay special attention to this section of LinkedIn. This is where you control who sees your profile, what updates you want people to see, who can search for you by your contact information, type of communication received and the frequency you may like to receive them from LinkedIn or individuals.

✓ Communication: Here, you want to ensure you activate email alerts for pertinent information – especially about job openings. To do this, go to, Settings/Communication/ Types of Messages you are willing to receive/check "Career opportunities," "Expertise requests," "Consulting offers," "Business deals," and "Job inquiries."

▸ Leverage the ability to add visual examples to promote your profile.

Images and/or documents provide a visual appeal and will make your profile stand out from the rest. To add media samples to the Summary, Education and Experience sections on your profile:

✓ Click on Profile at the top of your home page and select Edit Profile. Scroll down to the section where you want to add a sample and move your cursor over the add media icon.

✓ Select Upload File if you would like to display the media sample on your profile, or select Add Link if you want to link to content that exists on another web site.

If you choose to add a link, type or paste the link to your content into the Add a link field.

If you chose to upload a file, select the file from your computer. A picture of your file will display with pre-filled Title and Description fields.

You can customize these fields. Here are the acceptable file formats: Documents: . pdf, .doc, .docx, .rtf and .odt. Images: .png, .gif, .jpg and .jpeg and Presentations: .pdf, .ppt, .pps, .pptx, .ppsx, .pot, .potx and .odp. File size should not exceed 100 MB.

✓ Click Save. An update will appear on the home pages of your network, letting others know you added the media file or link unless you have this feature turned off.

▸ Optional Sections.

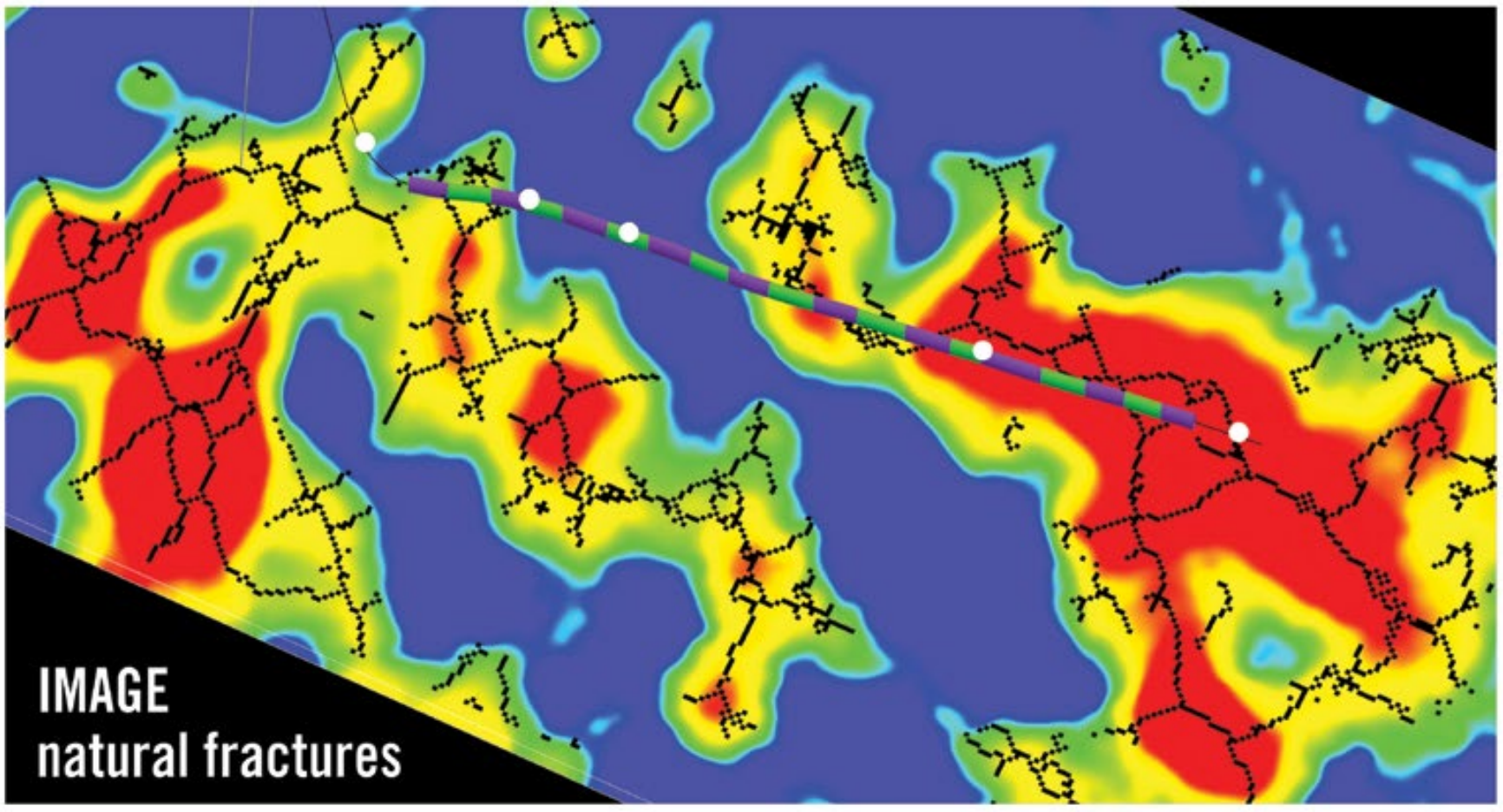
Take advantage of the optional sections to showcase your Awards, Honors, Certifications, Publications, Patents, Projects, Volunteer Experience, Organizations and any particular causes you may care about. This will certainly stand you out in the crowd. This is accessed via the profile/edit profile/add a section to your profile.

▸ Test your profile "findability."

Do a search on some of the key words you have highlighted on your profile plus your geographic location to see how easy or difficult to find you by recruiters. If your profile does not appear on the first few hits or pages you may need to optimize your profile even further.

Finally, always remember that authenticity is far better than findability – be original and credible in your profile representation.

Good luck with finding great opportunities.



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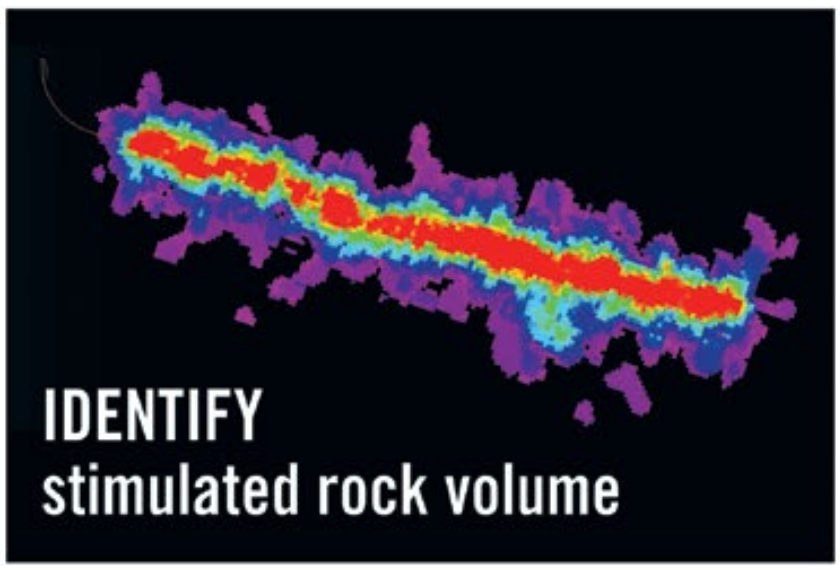

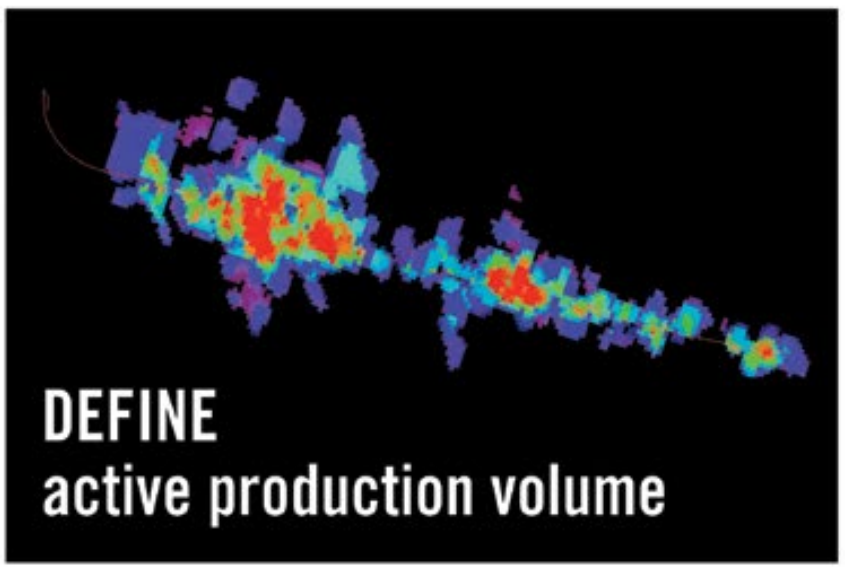

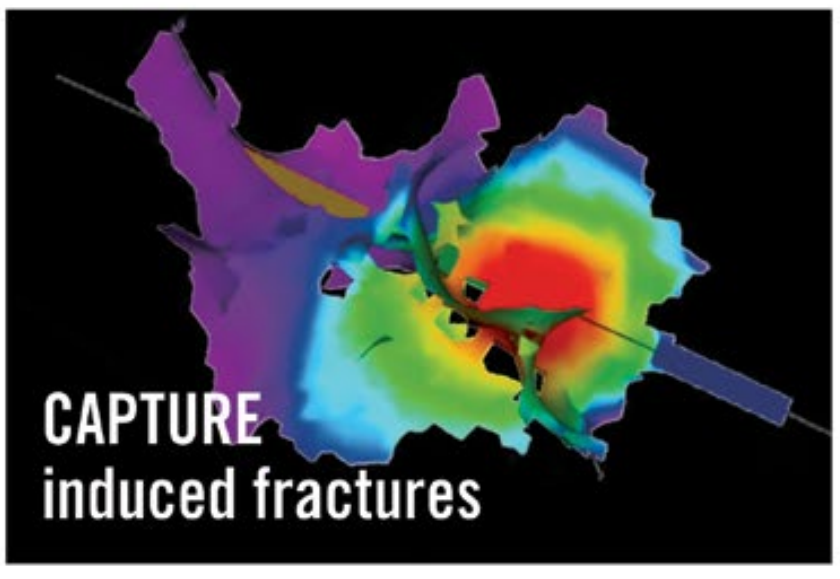

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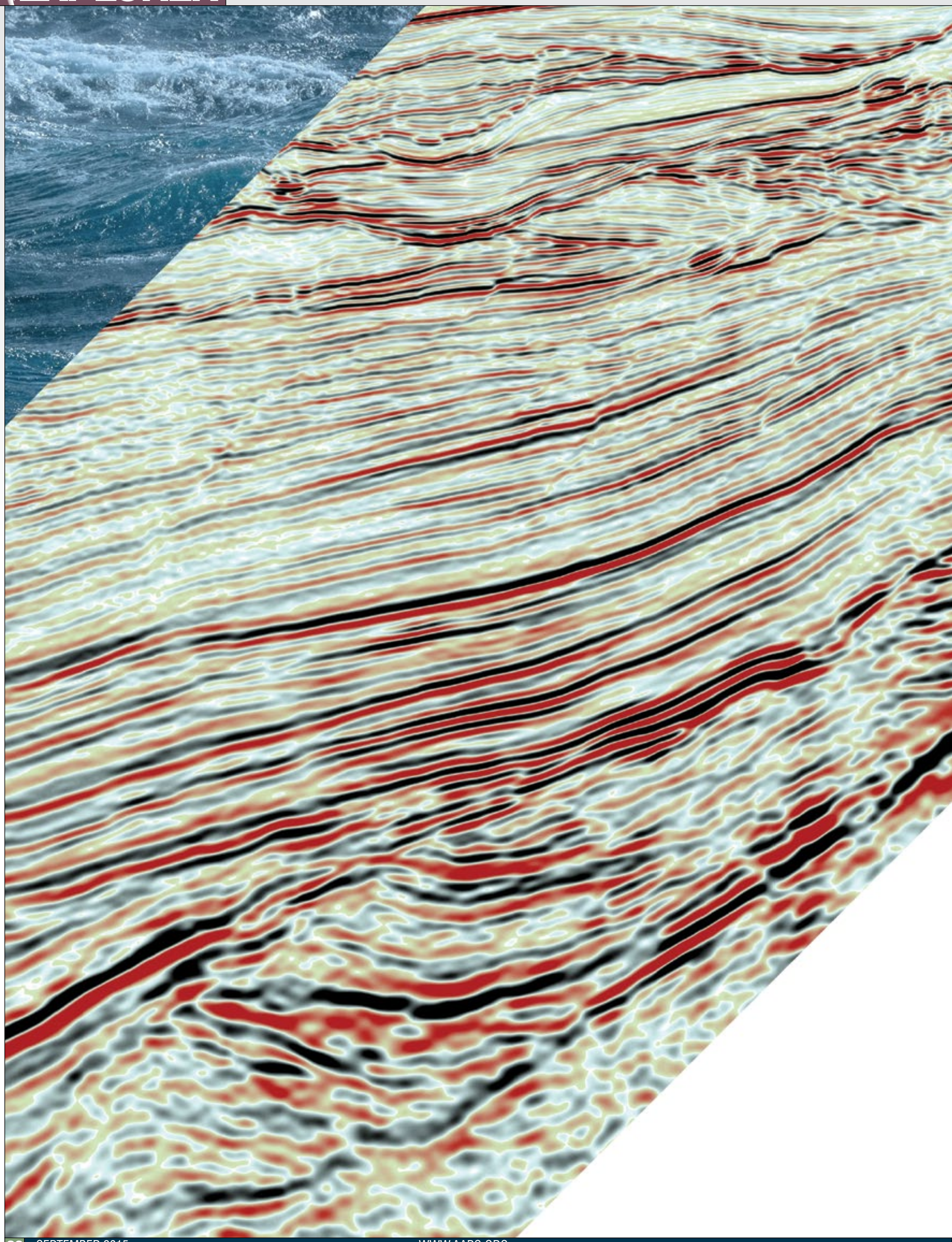
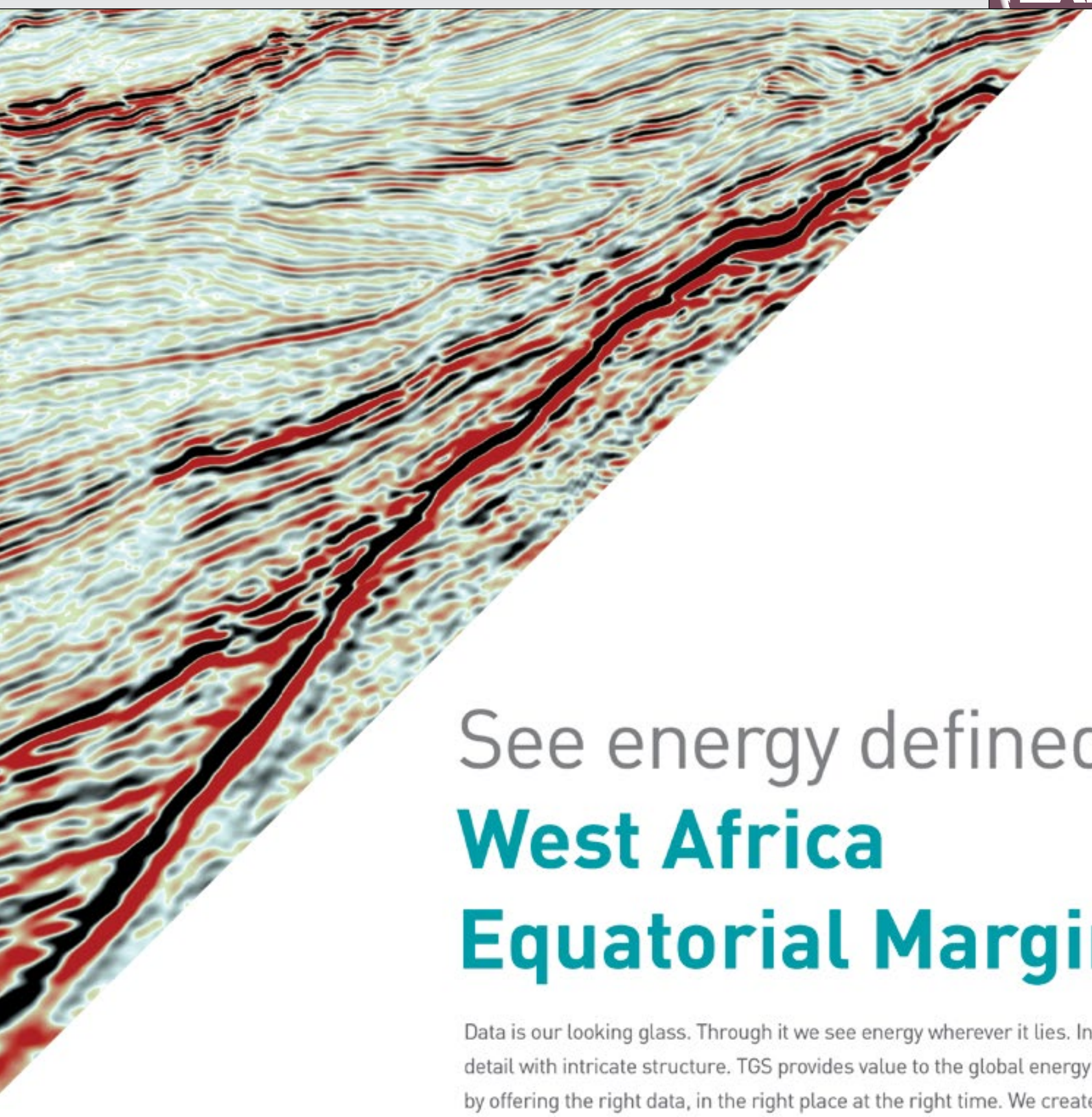




Angola Celebrates 100 Years of Oil Production

By TAKO KONING


KONING

A milestone event is occurring in Angola's oil industry this year – Angola celebrates 100 years since the first oil well was drilled in the country.

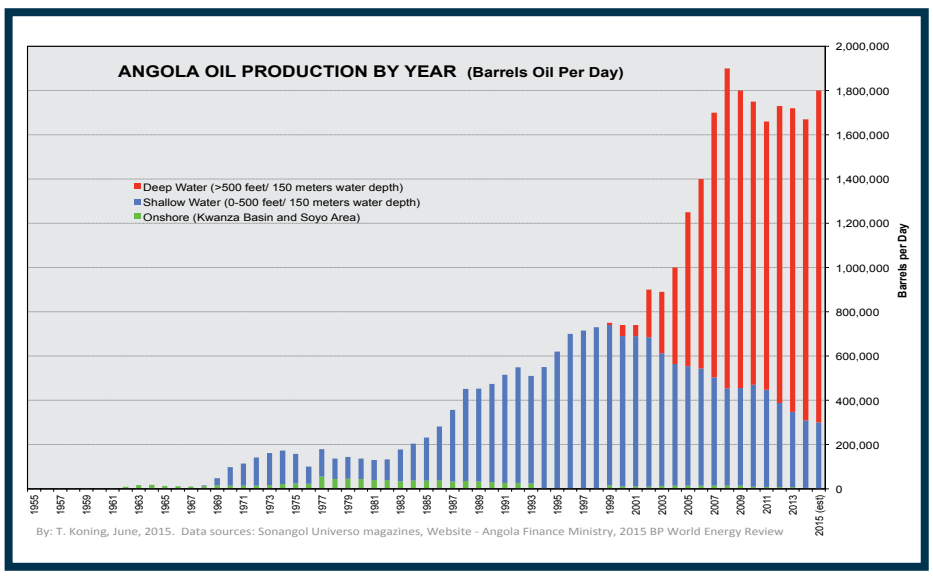
The first oil well, Dande-1, was drilled in the Dande River valley approximately 40 kilometers north of Luanda. Drilling began on March 25, 1915, and terminated four months later in July, as the well proved to be dry but drilling cuttings gave off a strong aroma of oil.

The well was drilled by the Portuguese oil company Pesquisas Mineiras de Angola (PEMA).

There are no historical records available to indicate why this location was chosen. The well was drilled before technology such as seismic, magnetic and gravity data was available. Oil seeps consisting of asphalt deposits are located northwest of the well site, which may have provided some incentive to drill the well. The seeps likely would have indicated to the geologists that oil had been generated in the area and had migrated updip and near to the outcrop edge of basement.

This area is today known as the Libongos asphalt deposits.

See **Revenue**, page 30




Angola's first oil well was drilled 100 years ago in the Dande River valley.

Milestones in Angola Oil Production

1968 – Pittsburgh-based Gulf Oil made the first offshore oil discovery in the Malongo oil field, Cabinda province of Angola.

1969 – The Malongo oil field commenced production, representing the first offshore oil production in Angola.

1975 – Texaco discovered the Essungo oil field, offshore Block 2.

1996 – French oil company Elf Petroleum discovered the Girassol oil field in Tertiary turbidites in the deepwater of the Lower Congo Basin; by 2001 Girassol was producing oil at 200,000 bpd.

2004 – Angola's oil production reaches one million bpd.

2008 – Angola's oil production reaches almost two million bpd.

2009 – ExxonMobil and its partners achieve one billion barrels cumulative oil production from deepwater Block 15.

2011 – Total and its partners mark one billion barrels cumulative oil production from deepwater Block 17.

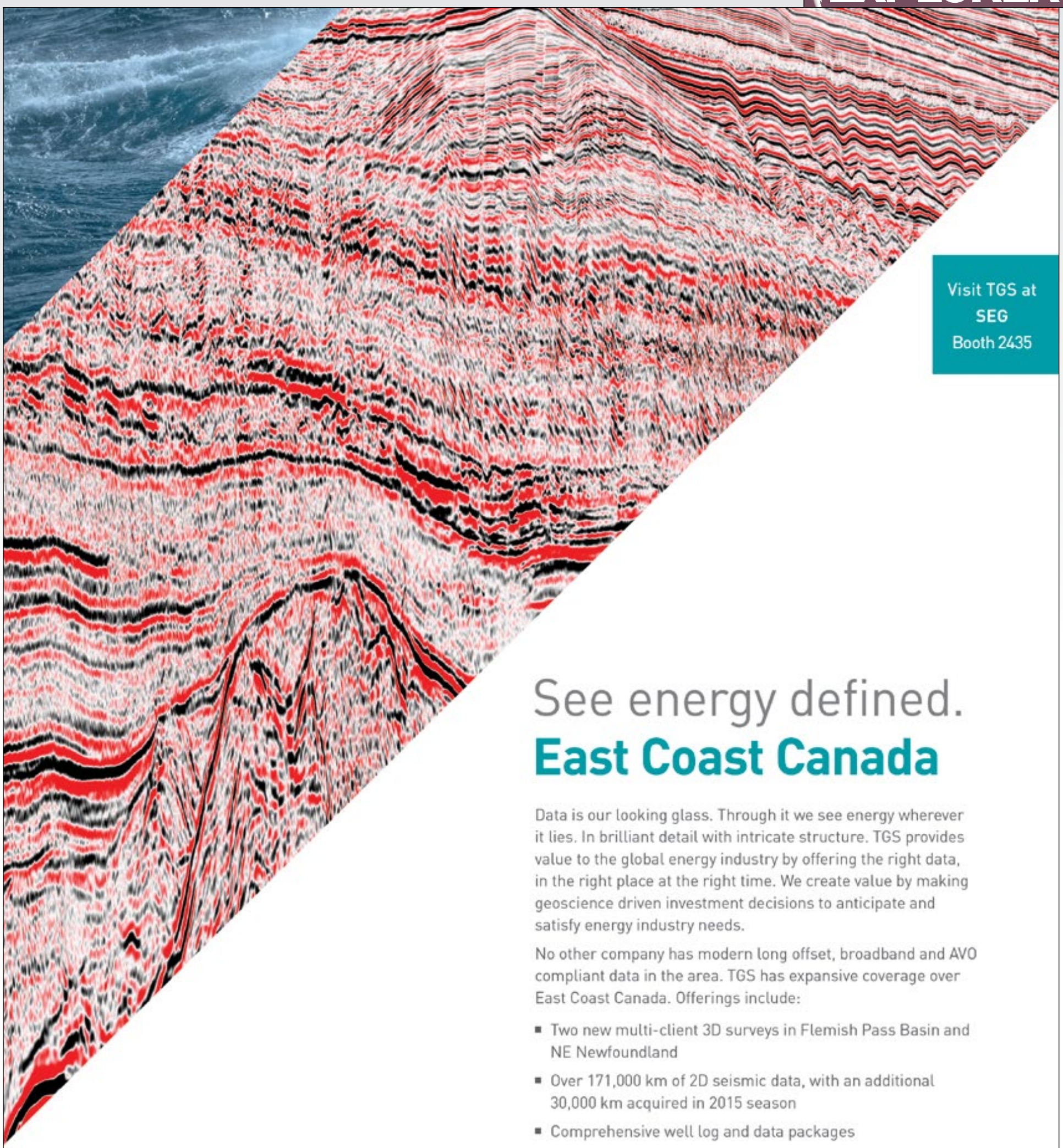
2011 – The state oil company, Sonangol awards 11 pre-salt exploration blocks in the deepwater Kwanza Basin.

2012 – Denmark's Maersk Oil drills Azul-1, which is the first pre-salt oil discovery in the deepwater Kwanza Basin. This was followed by Cobalt drilling the deepwater Cameia-1 pre-salt oil discovery.

2012 – Chevron and its partners achieve four billion barrels of cumulative oil production from shallow water Block 0, Cabinda.

2015 – Total and its partners make two billion barrels of cumulative oil production from deepwater Block 17.

2015 – Angola celebrates the 100th anniversary of oil drilling.



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Tako Koning, an AAPG Public Service Award winner, is a 33-year member of AAPG and is a long time resident of Angola where he currently works as a consultant for Gaffney, Cline & Associates. He also continues as a part-time (volunteer) Residential Representative for the Norwegian NGO, Yme Foundation, which drills wells for drinking water in rural areas of Cabinda province, Angola.

Eastern Section Meeting This Month in Indianapolis

The 2015 annual AAPG Eastern Section meeting will be held Sept. 20-22 at the Union Station and Crowne Plaza Hotel complex in downtown Indianapolis.

Previous Eastern Section meetings have been held in Indiana, including the 2009 meeting in Evansville and the 1999 meeting in Indianapolis.

As in 1999, the host will be the Professional Geologists of Indiana Inc. The 2015 Indy meeting will be a continuation of these past great meetings and a bridge to the future of regional petroleum exploration and production, as well as associated mineral and environmental industries.

There will be three field trips, three short courses, a series of student and YP-related events, including a student expo and job fair, as well as a full technical program with oral and poster sessions that will include the following themes:

- Shale and Unconventional Resources.
- Regional Geology and Reservoir Studies.
- Environmental and Policy Issues.
- Ordovician Regional and Reservoir Geology.
- Carbon Sequestration.

Indianapolis has a central location between the Illinois, Michigan and Appalachian basins and the Cincinnati, Kankakee and Finley arches, great interstate, rail and airplane access, and has been called "The Crossroads of America" due to the many intersecting transportation corridors. The historic and renovated Union Station train station is a popular and unique location for many meetings and events, and the adjacent former railroad head house has been converted into a modern hotel including renovated Pullman sleeping cars. Many restaurants, clubs, hotels, shopping and other attractions are within a few blocks. Indianapolis is the state capital, and a cultural and business hub, with many colleges and universities in Indy and nearby.

For more information, visit ESAAPG2015.org.

Revenue

from page 28

Two more wells were drilled and were abandoned due to the collapse of the casing.

On Aug. 14, 1916, Dande-4 was drilled to a depth of 857 meters and also abandoned, but the well tested six barrels per day of heavy oil. This represented the first-ever actual flow of oil in Angola.

World Records Set By Angola's Oil and Gas Industry

- In 2001, Total's Girassol FPSO (Floating Production Storage and Offloading) was the world's largest FPSO, with storage capacity of two million barrels of oil.
- In 2004, Esso's Kizomba FPSO, deepwater Block 15 was the world's largest FPSO. Thereafter, Chevron's Agbami FPSO in Nigeria held the world record, but Angola again holds the world record with Total's Pazflor FPSO currently holding the distinction.
- Chevron's Sanha LPG FPSO is world's largest LPG (liquified petroleum gas) hull ever built and first FPSO to combine LPG processing and export functions on the same unit. It contains the world's largest offshore gas compression facility.
- Chevron's BBLT (Benguela-Belize Compliant Piled Tower), Block 14, installed in 400 meters water, was the fifth largest free-standing structure in the world – and is the tallest man-made structure in Africa.
- The Angola LNG project is the world's first associated gas-fed LNG plant.
- During 59 years of oil production (1956-2015), Angola has never had a major drilling blowout nor oil spill.

Economic Impact

In 1919, a joint venture was formed with another Portuguese oil company, Companhia do Petroleo de Angola (COPA) and the American oil company, New York-based Sinclair Oil. This led to further exploration drilling until 1926, when drilling terminated due to lack of commercial discoveries.

Another three decades passed before the first commercial oil field was discovered by Portuguese oil company Petrofina in Benfica, a suburb on the southern edge of Luanda.

The discovery was Benfica-2, which was drilled in 1955 and commenced producing oil in 1956 representing a very important milestone in Angola's oil industry.

Oil revenue has provided Angola with about 95 percent of its foreign exchange and 50 percent of its GDP.

Angola suffered immensely during the long civil war from 1975 to 2002. With the end of the war, revenues provided by the oil industry have enabled the Angola government to rebuild the country with new roads, railroads, hydro-electric projects, airports, hospitals, schools and universities.

Marita Bradshaw: Moving Australia Forward

By HEATHER SAUCIER, EXPLORER Correspondent

Australia isn't commonly thought of as a global mecca for exploration and production, but the continent holds a great deal of potential.

Marita Bradshaw, an AAPG member and retired geologist with Geoscience Australia, has spent her career helping to uncover that potential and is now pleased to see recent large discoveries on the continent and the expansion of the export LNG industry – endeavors to which her work has contributed over the decades.

A symposium will be held in her honor this month at the AAPG-SEG International Convention and Exhibition (ICE) in Melbourne. There, she will speak about the history of paleogeography in Australian exploration and where she expects the science to go in the future.

"It has come a long way from the cartoon maps we used to draw with colored pencils," she said, "and still has a long way to go."

She explained that continent-wide paleogeography maps were produced in the 1980s in a cooperative project between government, universities and the petroleum and minerals industries. Draft versions were hand-colored paper maps, though the final published series became the precursors for computer-assisted map production in Australia.

Today, the light table and dusty well completion reports have been replaced by the computer screen linked to digital databases and visualizations of ancient geomorphologies extracted from 3-D seismic data volumes.

Martia Bradshaw in the field in central Australia.

Despite changes in technology, paleogeography maps still depend on data with robust time control, and their value remains in their predictive ability, whether interpolating at the reservoir field scale with 3-D- and 4-D-seismic control or extrapolating out hundreds of miles from the proximal basin edge into undrilled deepwater frontiers.

Uncovering Australia

Bradshaw became interested in geology as a child, growing up in a time when exciting missions to the moon caught the attention of the world.

"I noted that when the astronauts went to the moon, it was to collect rocks," she recalled.

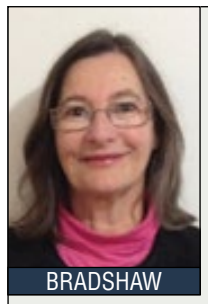
Her own interests in investigating plants, animals, rocks, aboriginal carvings and caves sealed her professional fate.

Bradshaw spent more than 30 years in petroleum geology, working for Geoscience Australia, the country's equivalent to the U.S. Geological Survey. She also worked in the industry with Esso Australia and Western Mining Ltd.

One of her first assignments in the 1980s was to work with a team to produce paleographic maps for 70 separate time slices from the Cambrian to the Holocene periods.

"The science was fascinating, looking at the whole continent, ignoring state borders and the current coastline, and instead seeing its evolution over hundreds of millions of years," she said.

See **Maps**, page 34



BRADSHAW

Marita Bradshaw retired from Geoscience Australia, the continent's equivalent to the U.S. Geological Survey, after more than 30 years in petroleum geology. She has long believed in Australia's hydrocarbon potential and pushed for exploration and development projects to move the continent forward.

She has always been willing to share her deep knowledge of Australia's sedimentary basins and petroleum systems with others, in hopes of prompting exploration efforts.

Her talk at the International Conference and Exhibition (ICE) in Melbourne, Australia this month will cover the history of paleogeography in Australian exploration and where she expects the science to go in the future. At ICE, a symposium will be held in her honor.

Maps
from page 32

The roughly 10-year effort generated detailed digital databases for Australian well data and biostratigraphic correlation charts.

"The synthesis of all the facies, age and geochemistry information led to the development of a classification of Australian petroleum systems," Bradshaw said.

In the early 1990s, Bradshaw got the chance to go to work on the deepwater edge of the North West Shelf, dredging up information from 2.5 to 3.7 miles down along the margin of what is now Australia's main hydrocarbon producing area.

"We were able to get rock samples showing that the Triassic sandstones, which now are the main gas reservoirs, extended all the way to edges of the Exmouth Plateau," Bradshaw said of the large, mid-slope continental margin plateau lying at water depths of 0.5 to more than 1.8 miles off northwest Australia. "We also found a Late Triassic-Early Jurassic carbonate belt out on the margin in places. One of these Late Triassic reef prospects has been drilled in recent years."

"Now, 25 years later, it is satisfying to see successful exploration on the outer margins of the North West Shelf, and that there are still key questions to be answered," she said.

Some of these questions include:

- The origin of the Exmouth Plateau – Is it underlain by Paleozoic oceanic crust as some have recently proposed?

- What is the extent to the Early Triassic oil play recently indicated by the Phoenix South discovery?

In 2007, Bradshaw had the opportunity to facilitate another dredging program in the highly underexplored Great Australian Bight off the coast of the south side of the continent.

"The funds, vessel, equipment, people, skills, science concepts and even the weather all lined up so that Geoscience Australia was able to collect the predicted oil prone source rocks from canyons incised into the sedimentary section along the margin of the Bight Basin," she recalled.

From paleogeography reconstructions and the geochemistry of stranded bitumens found along Australia's southern beaches, it was believed that mid-Cretaceous oil source rocks were present in the Bight Basin, Bradshaw said. Dredging targets were identified from seismic data and further pinpointed with detailed seafloor imaging so that Turonian oil prone shales were recovered in 2007, she added.

"Now we await the outcome of exploration where several companies have taken acreage positions and have drilling commitments," she said.

Getting On the Map

The fact that ICE is being held in Australia this year brings utter delight to Bradshaw, who has long believed in the continent's great potential for hydrocarbons and is now seeing her predictions fulfilled.

"Australia has great E&P potential," she said. "It already is a major exporter of LNG, both from conventional giant and super-giant offshore gas fields along the North West Shelf, and from the newly developed onshore CSG-LNG – the world's first major LNG project sourced from coal seam gas."

Bradshaw sees Australia as a continent with a great diversity of proven petroleum systems – "all the way from 'the oldest oil in the world,' recovered from Mesoproterozic rocks at 1.4 billion years old, right through to Cenozoic petroleum systems."

However, the continent doesn't get the exploration efforts required to find what is there, she said.

The scale of the industry is such that most effort is concentrated in the proven producing basins, and in recent years the focus has been on development and monetizing the giant gas resources, rather than exploration into frontier basins, she explained.

Yet, the investment climate in Australia is very favorable with low above-ground risk, easy access to data, and profit-based petroleum taxation.

"Some government initiatives – such as well and seismic data that is collected and eventually becomes open file for other explorers to use – help," she said. "But a big oil discovery in a new area such as the Great Australian Bight would really help put us on the map."

Student Chapter videos

Showcasing AAPG's Global Community

By BARRY FRIEDMAN, EXPLORER Correspondent

You wouldn't be wrong if you thought of this year's AAPG Student Chapter YouTube video contest as sort of a geoscience department "selfie" – and we all know how fun and popular those creative bursts can be.

In order to foster both excitement and pride in the work being done in geology departments on university and college campuses, the annual student chapter video contest – now in its fourth year – has become a way for these student organizations to highlight their commitment to geology.

And, in the process, if they also prove they're not master filmmakers, well, that's part of the fun.

But don't just take our word for it. Consider 2015 participant Alyssa Charsky, from the Colorado School of Mines, who said it's exactly the kind of effort that AAPG should be encouraging.

"I think that the YouTube video contest is a great way to showcase the yearly accomplishments of each of the student chapters," she said, "and for each chapter to take pride in their organization."

To see these videos is to see the study of geology from those most affected by it – the students.

These short videos, at their best, can be seen as promotional pieces for their individual departments – often quirky and serious with some great musical beds – but also as an introduction to the future leaders of the profession and industry.

1st place winners, the University of Pembangunan Nasional Veteran.

It is, in many ways, an overview on the work being done *and* the work they hope to do, as well as their philosophies at this moment, goals and rationales.

Lights, Camera …

Participating teams in the video contest were asked to submit no more than a three-minute video. Once the chapters – and this year, there were 18 in all – submitted their videos, each participating school got to vote on whose was the best.

Then the fun began.

Once the schools voted, the videos were posted on Facebook and YouTube, where the number of LIKES also were tabulated. From all three sources, a winner was named – University of Pembangunan Nasional Veteran. The University of Bandung and Brawijaya University won 2nd and 3rd, respectively.

Specifically, for the Colorado School of Mines video, Charsky said part of its approach was to determine what other schools would be presented – and to do something else.

"For our video we wanted to highlight the diversity of our community and events we hosted. We chose to interview a number of professors and students and included sound bites from each of them to make our video more personal and show how the organization has positively impacted these individuals. We thought that this was a more effective way to communicate the successes of our chapter than by only using text overlays on images as some schools choose to do."

Action

As mentioned, seventeen other schools entered this year's contest, and the videos were featured in Denver during ACE. You can see their videos online at http://aapg.to/yt2015sc.

The videos, as you can see, reveal both an excitement to the world of geology and an expectation to how that world will be molded in the future. (You'll also notice different fashion choices, from unisex uniforms at some schools to what can best be described as dorm chic at others.)

Charsky is well aware her chapter's entry was not world-winning cinematography.

"The most challenging part of this contest was realizing the level of video-making expertise that other schools had available to them, and that none of our

See **Video Improvement**, page 40

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A new chapter in the energy security discussion

Iran and U.S. Energy Exports

By EDITH ALLISON, Geoscience and Energy Policy Office Director

Congress long has been interested in ending the ban on the export of U.S. crude oil (see July 2014 Policy Watch) – and their interest in oil exports has increased with the recent international agreement to lift the nuclear-related sanctions on Iran.

At the same time, however, some legislators continue to oppose exports because they could raise prices to consumers and increase the environmental impacts of oil production.

Republican Sen. John Cornyn of Texas, speaking at a Center for Strategic and International Studies (CSIS) forum in July, described an energy security argument for ending the U.S. export ban, noting that oil exports are an international security weapon as shown by the convergence of European dependence on Russian oil and gas and their hesitancy to confront Russia regarding Ukraine.

Making U.S. oil and gas available to our European allies, he continued, could be an important foreign policy mechanism to assure a unified front in dealing with an increasingly aggressive Russia.

The senator also proposed another potential strategic benefit: Increasing U.S. oil exports would blunt Iran's attempts to benefit from increased oil sales that could boost its military influence in the region.

A recent report by the Atlantic Council adds to these arguments, observing that if it becomes necessary to reinstitute oil export sanctions on Iran, the European community will be more accommodating if the United States is contributing to global oil supplies.


ALLISON

> **Oil exports are an international security weapon ... Making U.S. oil and gas available to our European allies ... could be an important foreign policy mechanism.**

The report also notes the benefit of allowing crude exports to Mexico, which would help its refining industry gain access to light oil; currently, oil exports to Canada are allowed while exports to Mexico are banned.

Another popular argument for oil exports is that if we will allow unlimited Iranian exports, it is only fair then to allow U.S. oil exports.

In addition, U.S. producers' continuing interest in selling oil at higher global prices is amplified with this year's price drop, as the price spread between U.S. and global prices represents a larger percentage of the low price.

A March 2015 IHS analysis found that lifting the ban on crude oil exports increases supply chain jobs and economic activity by:

- Stimulating capital investment.
- Increasing crude oil production.
- Lowering gasoline prices.

Representing the other side of the issue, Democratic Sen. Ed Markey of Massachusetts and 12 other senators sent a letter to President Obama on June 26 listing their objections:

- Weakening or repealing the oil export ban could harm our national security, because we are and will continue to be dependent on foreign oil.
- Exports could harm refineries that are in the process of making upgrades to deal with greater domestic production and increasing volumes of light oil – we essentially would be exporting our refining capacity.
- There could be an increase in consumer costs and in the volumes of oil transported across the United States, which increases the risk of spills.

Refiners, who currently export large volumes of refined products, generally have been opposed to crude oil exports, which would decrease their refining margins. However, recently the refining units of four multi-national, integrated oil companies – Shell, ExxonMobil, Chevron and BP – sent a letter to the House and Senate energy committees supporting an end to the export ban.

Some small refiners continue to voice their opposition to oil exports.

Legislation

Both the House and the Senate held hearings this spring and summer on the benefits of crude oil exports. In addition, members of both chambers have introduced bills to end the export ban.

Comprehensive energy legislation also is working through the House and Senate, and oil and natural gas export provisions were expected to be part of both bills. However, as Congress started their summer recess, the House Energy and Commerce and the Senate Energy and Natural Resource committees excluded oil export provisions from their comprehensive bills in the interests of maintaining bipartisan support.

The Senate bill does include provisions to expedite LNG exports.

Comprehensive energy legislation passed the House Energy and Commerce

See **Exports**, page 40

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AAPG Education

Video Improvement
from page 36

video team members had any formal video editing filming or training. While we stand by the content of our video, I feel that we could have benefited from a better editing software or someone with more filming/editing experience – especially since a few of the winning videos the past few years looked like they had been professionally made."

Since 2008, the YouTube student video contest has grown exponentially and, according to Bryant R. Fulk, an AAPG member, who started his AAPG career at San Diego State University (which has won the contest the previous two years), and who now heads the Student Chapter Committee for AAPG, sees the quality of these videos – and one imagines the chapters, as well – improving yearly.

"My impressions," he said, after viewing this year's submissions, "are that the students continue to compile an amazing deliverable. Every year the videos improve in quality and most importantly the kinds of events that the student chapters are documenting are broadening in their impact. The top videos are clearly work intensive and AAPG appreciates the students sharing their experiences through this media."

All in all, Charsky added, "I enjoyed being a part of our video team this year because it made me really appreciate the dynamic community that AAPG has created on our campus – we interact with and influence more than just petroleum geologists."

Exports
from page 38

Committee, chaired by Michigan Republican Rep. Fred Upton, on July 9. This draft of the bill, designed to be bipartisan, focuses on electricity reliability, natural gas infrastructure and workforce training – and is not loaded with partisan topics such as oil exports.

Oil and gas export provisions may appear when bill comes before the full House in September.

In the Senate, the comprehensive energy bill (the Energy Policy Modernization Act of 2015) contains provisions on efficiency, infrastructure, land and water conservation, and updated federal procedures. The bill would accelerate government approvals of LNG exports. However, legislation allowing crude exports was moved to a separate bill and passed by the Senate committee amid discussion that authorizing oil exports could be paired with an extension of renewable energy tax incentives when the legislation comes before the full Senate.

Impacts of the Iran Agreement

Iran will regain access to international energy markets and the global financial system once the International Atomic Energy Agency (IAEA) verifies that Iran has met restrictions on its nuclear program – probably several months from now.

Estimates of potential post-sanctions oil exports are varied:

- The National Iran Oil Company managing director said production could increase by 500,000-600,000 barrels per day (b/d) almost immediately, and total exports could grow from about 1.5 million b/d to pre-sanction levels of four million b/d within six to 12 months if there is sufficient demand.
- Reuters reports that analysts expect an increase from 200,000 and 700,000 b/d.
- Additionally, an unknown volume of oil in floating storage could come on the market in 2016.

In addition to the United Nations' nuclear sanctions that are being lifted, the United States has special sanctions – during the 1979-81 hostage crisis the country froze Iranian assets, and in 1984 it designated Iran a state sponsor of terrorism, which automatically triggered sanctions, including restricting foreign assistance, economic interactions and arms transfers, and restricting export of dual-use items.

A May 2015 law restricts the president's prerogative to waive U.S. sanctions without congressional approval. Continuing U.S. sanctions may limit businesses or individuals engaging in commercial transactions with Iran. The European Union also has nuclear-related and other sanctions that can be lifted by votes of the 28 member-states.

Increasing Iranian oil exports may put downward pressure on already-low oil prices that reflect a large global surplus. The U.S. Energy Information Administration estimates that 2015 global oil inventory (amount that production exceeded consumption) grew 2.2 million b/d in the first half of 2015, but rising demand and slowing production growth will cut inventory builds to 1.5 million b/d in the second half of 2015 and 0.6 million b/d in 2016. These figures assume that Iranian production will change little through the first quarter of 2016. However, EIA estimates that re-entry of more Iranian oil could lower its 2016 price per barrel forecast by $5 to $15.

Oil sales from the U.S. Strategic Petroleum Reserve (SPR), which contains about 695 million barrels of crude oil, also could push down oil prices.

A test sale of five million barrels in 2014 did temporarily push down futures prices, but the sale volume was too small to have any significant impact. Now, with the growth in domestic production and decline in imports, SPR contains more oil than is required to help meet its treaty obligations to hold the equivalent of 90 days of imports.

That makes SPR look like a giant piggy bank to some in Congress – bills have been introduced in Congress to sell SPR oil to fund the Highway Trust Fund (101 million barrels) and increase funding to the National Institutes of Health (64 million barrels).

Whether these proposed sales will have a significant impact on oil prices depends on their timing.

The Geophysical Corner is a regular column in the EXPLORER, edited by Satinder Chopra, chief geophysicist for Arcis Seismic Solutions, Calgary, Canada, and a past AAPG-SEG Joint Distinguished Lecturer. This month's column deals with generating more accurate low-frequency models for impedance inversion.

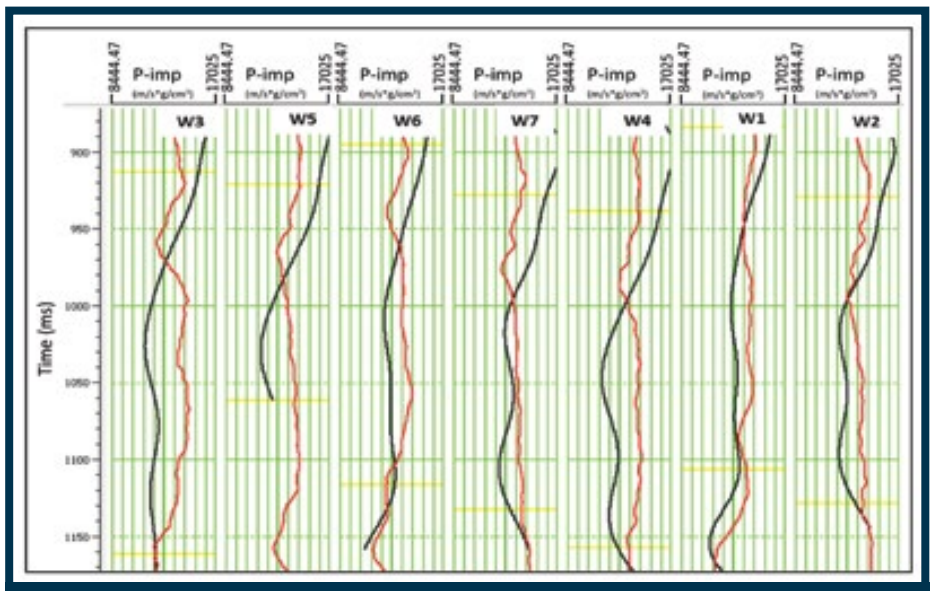

Figure 1 – Match between the modeled impedance log and actual filtered impedance log curves using multi-attribute regression with use of seismic data and the derived seismic attributes. Black curves represent the filtered impedance logs and red curves represent the modeled impedance curves. Analysis window is marked with yellow bars. A poor correlation coefficient of 0.4 is observed.

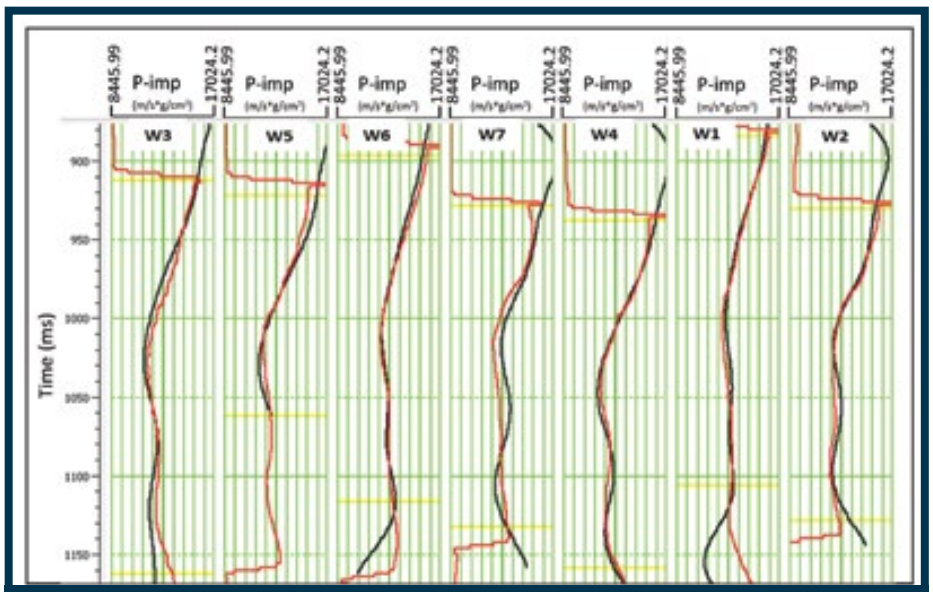

Figure 2 – Match between the modeled impedance log and actual filtered impedance log curves using multi-attribute regression analysis on including single well low-frequency model as one of the inputs. Black curves represent the filtered impedance logs and red curves represent the modeled impedance curves. Analysis window is marked with yellow bars. Correlation coefficient improves significantly to 0.96.

Finding a Better Path to Impedance Inversion

By AMIT KUMAR RAY, RITESH KUMAR SHARMA and SATINDER CHOPRA

A recent series of Geophysical Corner articles (May, June and July 2015) focused on impedance inversion of seismic data, and how it allows the estimation of elastic properties for reservoir characterization.

For making qualitative predictions about the reservoir, a simple transformation of the seismic amplitudes into impedance values is good enough. Such an impedance section will show relative impedance changes, which may not match the impedance log data in terms of absolute values.

As discussed earlier, the low-frequency band (less than 10Hz) of the frequency spectrum is missing in the seismic data – and consequently, the transformed impedance data also have this frequency band missing.

This low-frequency band can be extracted from the impedance well log curves and added to the transformed impedance data, when their values – now called absolute values – match the values seen on the impedance log curves.

* * *

The low-frequency band we refer to here is first constructed in the form of a model, which may be 2-D or 3-D, depending on whether the data being inverted is 2-D or 3-D.

The low-frequency model is constructed such that the different subsurface interval impedance values are constrained by the horizons interpreted on the seismic data.

This leads to more meaningful inverted impedance data.

As we begin to use such inverted data, we realize we are in for surprises:

- For a 2-D seismic profile passing through some wells, when the low-frequency trend extracted from a single well is used in the impedance inversion, the impedance section may or may not match the impedance logs at the other well locations.

- Similarly, if a single-well low-frequency trend is used for inverting a 3-D seismic volume, we often run into a similar problem.

Another way to generate a low-frequency model is to make use of a few wells for generating the low-frequency model for inclusion in the impedance inversion. Such a technique linearly interpolates the impedance data between the wells using weights calculated on the basis of inverse distance, and similarly extrapolates away from the well control.

When quality checks are performed on the generated low-frequency models using this technique, they often are found to exhibit artifacts in the form of artificial tongues with anomalous impedance values, appearing more like bull's eyes.

Such patterns are not geological and do not generate meaningful impedance sections or volumes.

* * *

This month we discuss a new workflow for building a low-frequency model for impedance inversion that uses both the well log data as well as seismic data.


RAY


SHARMA


CHOPRA

Suitable attributes derived from seismic data, as well as the data from different wells, are used to estimate a linear regression relationship. This relationship is then used to predict the low-frequency component for use in impedance inversion.

The steps followed in the workflow are described below and are applied to a dataset from northeast British Columbia in Canada.

- First, we generate a low-frequency impedance model using a single well. This model represents the overall compaction trend within the 3-D volume.

- Next, we carry out model-based impedance inversion on the 3-D seismic volume.

As mentioned above, the log correlation at other wells may not be satisfactory, which is found to be true in this case study.

- Before we go further it is important to understand the idea behind the use of multi-attribute regression.

In this case, the objective of multi-attribute analysis is to find a relationship between the well log data and seismic data at the well locations. Once this relationship is obtained it will be used to predict a volume of the log property at each trace location of the seismic data.

A simple way of doing this is to crossplot the two in the broad zone of interest, where a cluster of points is usually seen. A best-fit or regression line is then drawn through the cluster of points, which represents the relationship between the two variables crossplotted.

In such cases in general, however, a large scatter of the points is noticed on the crossplots, which prevents us from using a single seismic attribute for predicting the target log property.

For improving upon the scatter of points on the crossplot, we try bringing in more attributes in our analysis and executing the multi-attribute regression analysis.

In this analysis, the target log is modeled as a linear combination of several input attributes at each sample point. This modeling yields a series of linear equations, which are solved for obtaining a linear weighted-sum of the input seismic attributes in such a way that the error between the predicted and the target log is minimized in a least squares sense.

We began with the multi-attribute analysis for first determining the low-frequency impedance curves at well locations from seismic attributes, comparing them with the real log data and then using the determined multi-attribute transforms to generate such curves at all the traces in the

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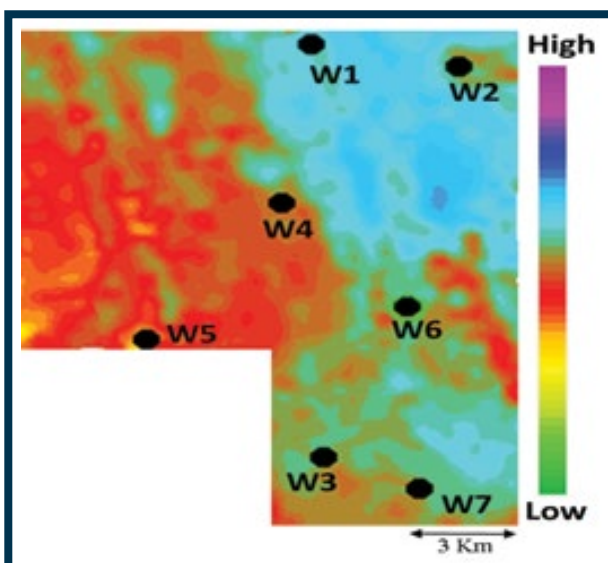

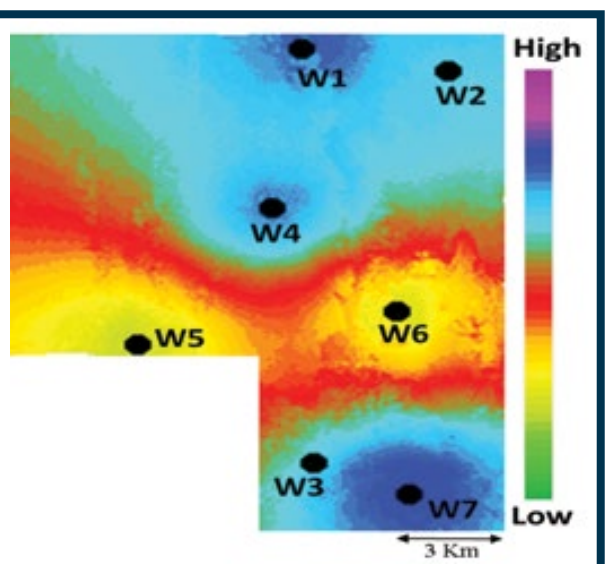

Figure 3 (left) – Horizon slice in the zone of interest for the low-frequency model generated using multi-attribute regression method. Figure 4 (right) – Horizon slice in the zone of interest for the low-frequency model generated using inverse distance interpolation method. Notice the bull's eyes on the display, which would show artifacts on impedance inversion output.

Continued from previous page

seismic volume. Different seismic attributes such as relative acoustic impedance from colored inversion, instantaneous attributes and different filtered versions of seismic data were used for the purpose.

Figure 1 shows the outcome of this analysis, which is a match between the predicted low-frequency impedance curve (red) and the actual low-frequency curve (black) for different wells. For each of the wells, a poor correlation is seen between the two types of curves over the target window that includes the broad zone of interest indicated with the yellow bars.

Disappointed with the poor correlation, we repeat the previous step by bringing in the low-frequency model derived using a single well in step 1 as another attribute, along with the other seismic attributes. In figure 2, we show the match between the predicted impedance log using this workflow and the actual filtered impedance log curves.

Notice now there is a very good correlation between the two sets of curves at each well location.

Encouraged with this result, we go through another process called cross-validation, wherein we exclude one well from the analysis in the previous step and then use the process to predict it. This analysis is repeated as many times as there are wells on the 3-D volume.

Once this is done, the cross-validation prediction error is calculated at each of the well locations, which in this case was found to be very low. This step is used to gain confidence in the applicability of the present approach.

▸ The multi-attribute regression analysis is now run for the full volume, and the low-frequency model is computed.

The output volume was examined for its quality and a horizon slice from this volume is shown in figure 3.

We observe there is a gradual transition of low frequency impedance from one well to another as we expect. In contrast to this we show an equivalent horizon slice from the low-frequency impedance volume generated using the inverse-distance interpolation method.

Notice the pronounced low-frequency impedance anomalies appear as bull's eyes at wells W5 and W6, which will surely result in artifacts when used in impedance inversion.

Conclusions

The proposed workflow for generating a low-frequency impedance model is superior to the existing methods of low-frequency impedance generation. The quality of the low-frequency impedance model used in the inversion has a pronounced effect on the final impedance result, and thus a superior low-frequency impedance model when used in the inversion process yields a more accurate impedance inversion output.

Our work on other such exercises corroborate this conclusion.

We recommend this workflow for carrying out estimation of elastic parameters for quantitative interpretation of seismic data – especially when there is lateral variation of the impedance from well-to-well through the 3-D volume.

We thank Arcis Seismic Solutions, TGS, for allowing us to present this work.

(Editor's note: The authors are all with Arcis Seismic Solutions, TGS, Calgary, Canada.)

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.

Digging the Roots of Hydraulic Fracturing

By LAWRENCE H. SKELTON

Hydraulic fracturing of rock formations – or "fracking," as it is now called by the public – has been hotly debated during the past several years, and public opinions have resulted in numerous legislative actions that closely control or even ban the practice in different parts of the nation.


SKELTON

Fracturing, however, actually has been used in the oil and gas industry for 67 years and in the granite quarrying business in North Carolina since 1903.

It is surprising that the energy industry didn't develop the concept of hydro-fracturing much earlier. Perhaps that is due to a frequent lack of communication between hard rock and petroleum geologists.


Photo courtesy of Kansas Geological Survey

Stanolind's Klepper fracturing test in Grant County, Kansas, 1947.

Blast Off

Fracturing oil or gas wells actually began in 1865 in Pennsylvania, where the practice of "shooting" wells began. In January 1865, Edward A.L. Roberts, a recently cashiered army officer of the 28th New Jersey Volunteer Infantry Regiment, conceived the idea of clearing a clogged well bore by Oil Creek near Titusville, Pa., by blasting it with eight pounds of gunpowder.

That process was successful enough to gain Roberts a U.S. patent by fall of 1866.

By using a larger charge, up to 20 pounds of black powder in an iron container having a percussion cap wired to its top (termed a "torpedo") and filling the hole with water to concentrate concussion, better fracturing around the explosion depth resulted – and production in some wells increased as much as 1,200 percent in one week.

Roberts soon figured out that nitroglycerine, invented in 1846, would be a preferable explosive – cleaner and more powerful – and use of nitroglycerine quickly outpaced that of black powder.

At first, four to six quarts of nitroglycerine comprised the charge, but as time progressed and wells were drilled deeper, the charge was increased to 60, 100 and 200 quarts.

The nitroglycerine was poured into a four-foot long, galvanized iron tube that had a conical bottom and concave top to allow another torpedo to nestle into the previous one. As a safety measure, the torpedo initially was filled with water that was displaced as the heavier nitro was decanted.

The loaded torpedo was then lowered down the well bore by a line to the desired depth, and a weight (the "go-devil") was attached to slide down the line – or it could be free dropped to impact the nitro-filled torpedo.

The term "go-devil" is said to have originated because as soon as the shooter released it, he had to "go like the devil" to exit the rig floor before impact.

Needless to say, there were many spectacular and tragic accidents.

Pennsylvania author John James McLaurin in his 1896 book "Sketches in Crude Oil" described the danger:

"A flame or a spark would not explode nitroglycerine readily, but the chap who struck it a hard rap might as well avoid trouble among his heirs by having his will written and a cigar box ordered to hold such fragments as the weeping relatives could pick from the surrounding district."

By the late 1940s, the DuPont Corporation had developed a desensitized product termed "red glycerine" that virtually replaced nitroglycerine as a means of well shooting.

Nevertheless, use of nitroglycerine continued. As late as May 1978, 380 quarts of the explosive detonated and destroyed

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a three-story plant near Titusville, Pa. The shock was felt six miles away, and debris was spread over a three-quarter mile radius.

A Good Start

It is possible that the hazards of nitroglycerine initiated research in alternative methods to improve permeability in oil well producing zones.

The first experimental hydro-fracturing test in the oil and gas industry was the result of a study by Stanolind's Floyd Ferris on the relation between treatment pressures and well performance. The test was performed on the Stanolind (the exploration and production subsidiary of Standard Oil of Indiana – now BP-Amoco) Klepper Gas Unit Number One, located in the center of Section 8, Township 29 South, Range 38 West in Grant County, Kan., in the giant Hugoton gas field.

The well was drilled to 2,580 feet and completed in November 1946. It was shut in early in 1947 due to producing zone strata being clogged with drilling mud, but soon re-entered to try a newly developed fracturing technique.

The Klepper was fractured at a depth of 2,400 feet using a thousand gallons of a napalm mixture of blended palm oil, napthenic acid and gasoline with sieved and washed sand from the nearby Arkansas River to serve as a proppant. After fracturing, the well was treated with 20,000 gallons of hydrochloric acid.

No particular gain was reported, but apparently all were satisfied with the results, because the following year J.B. Clark of Stanolind published a paper that advised the industry of the experiment – and in 1949, Stanolind was issued a patent on the process.

With a patent in hand, Stanolind then granted an exclusive license to the Halliburton Oil Well Cementing Company, who in March 1949 performed the first two commercial hydrofracturing jobs:

- The first, near Duncan in Stevens County, Oklahoma, cost $900.
- The second at Holliday in Archer County, Texas, at cost of $1,000.

The fracturing fluid was lease crude oil or a crude/gasoline blend with 100 to 150 pounds of sand. Results must have pleased the well operators, for Halliburton did 332 fracturing jobs that first year.

The Atomic Age

Never content with progress, the federal government decided to "improve" the well-fracturing process.

In 1957, the (then) Atomic Energy Commission (AEC), Sandia National Laboratory and Lawrence Livermore National Radiation Laboratory began secret meetings to discuss possible peaceful applications of nuclear weapons. The end result was Project Plowshare, which shared several intriguing applications.

Of interest to the oil and gas industry was the use of "nukes" to fracture tight, gas-bearing strata to release the gas. The AEC and commercial energy corporations were to be involved in the tests.

The first test, Project Gasbuggy, a joint project of the AEC and El Paso Natural Gas, was performed on Dec. 10, 1967, some 50 miles east of Farmington, N.M. A device yielding the explosive power of 20 kilotons of TNT was detonated at 4,227 feet below the surface, creating a surface crater that was 335 feet deep and 80 feet in diameter.

The test was successful in that natural gas was released – but, unfortunately, was too radioactive to be of any commercial use.

A second test was made: AEC, Austral Oil and CER Geonuclear Corp. teamed up for Project Rulison, a 40-kiloton shot on Sept. 10, 1969, at a site 14 miles southwest of Rifle, Colo. This test, too, resulted in radioactive gas in addition to radioactive contamination of deep bedrock around the shot cavity as well as some possible surface contamination.

Perhaps thinking the third time's the charm, another test, Project Rio Blanco, was planned. AEC and CER Geonuclear partnered again, this time joined by Conoco.

A site in Rio Blanco County about 33 miles northwest of Rifle, was chosen. The hole would be shot in low permeability,

See **Improvements**, page 48

Weeks Grant Provides Educational Opportunities for Undergrads

By APRIL STUART, AAPG Foundation Programs Coordinator

The AAPG Foundation's L. Austin Weeks Undergraduate Grant program annually awards deserving geoscience students and geoscience student organizations across the world with $500 in grant funds. These international grants support the educational expenses of undergraduate geoscience students and their associated student organizations.

In 2015 the program was expanded to accept applications from individual students, student-led geoscience associations and clubs in addition to applications from AAPG student chapters.

The response was tremendous.

The applications far exceeded the total number of awards available. The Foundation received more than 350 applications–255 from students and 95 from student organizations. This year the number of awards available totaled 152 grants. The proportion of awards was split equally between individual students and student organizations.

This year the student and organization applications were reviewed by a selection panel composed of AAPG trustee associates including Denise Cox, Jim McGhay, Ron Nelson, Steve Laubach and Valary Schulz-West. The award criteria focused on students and student organizations' scholastic performance, intended use, and leadership activity. Each winning student and student organization received $500 in grant funds.

The Geoscience Student Club at the ENSEGID School of Bordeaux.

Award-winning students may use the grants to purchase much needed equipment required for hands-on exploration, such as rock hammers and compasses, also and are able to apply the funds toward tuition, books and fees. Student organizations may use the funds to support group activities through the purchase of necessary field equipment and are able also to apply the funds towards geology field trips and conferences.

The increased interest from this year's grant cycle shows a need for greater funding in the area of undergraduate geoscience education. We know that the financial need will continue to grow and we hope the results from this award cycle highlight the necessity to focus fundraising efforts for undergraduate geoscience education across the world.

Thanks to the expansion of the program, one geoscience club hopes to build an official AAPG Student Chapter at ENSEGID School of Bordeaux (France). Student representative Armand Moreau wrote in a thank you letter to the Foundation:

"The Geoscience Student Club at the ENSEGID School of Bordeaux (France) is thrilled and proud to have received the L. Austin Weeks Undergraduate Grant from the AAPG Foundation.

"We would like to thank the different contributors and the members of the Foundation for this grant and for their trust in our association. This money will help us to organize geological field trips during the coming year, a great opportunity to gain more knowledge and experience in the field.

"We are now even more motivated to build an official AAPG Student Chapter in our school, which will allow us to bring together all the geological students of Bordeaux and to organe more events, conferences and field trips. This is our next step!"

If you are interested in volunteering for the L. Austin Weeks Undergraduate Grant Committee to help select student recipients, or in making a contribution to support the program, please contact Foundation program coordinator, April Stuart, at astuart@aapg.org or (918) 560-2664.

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

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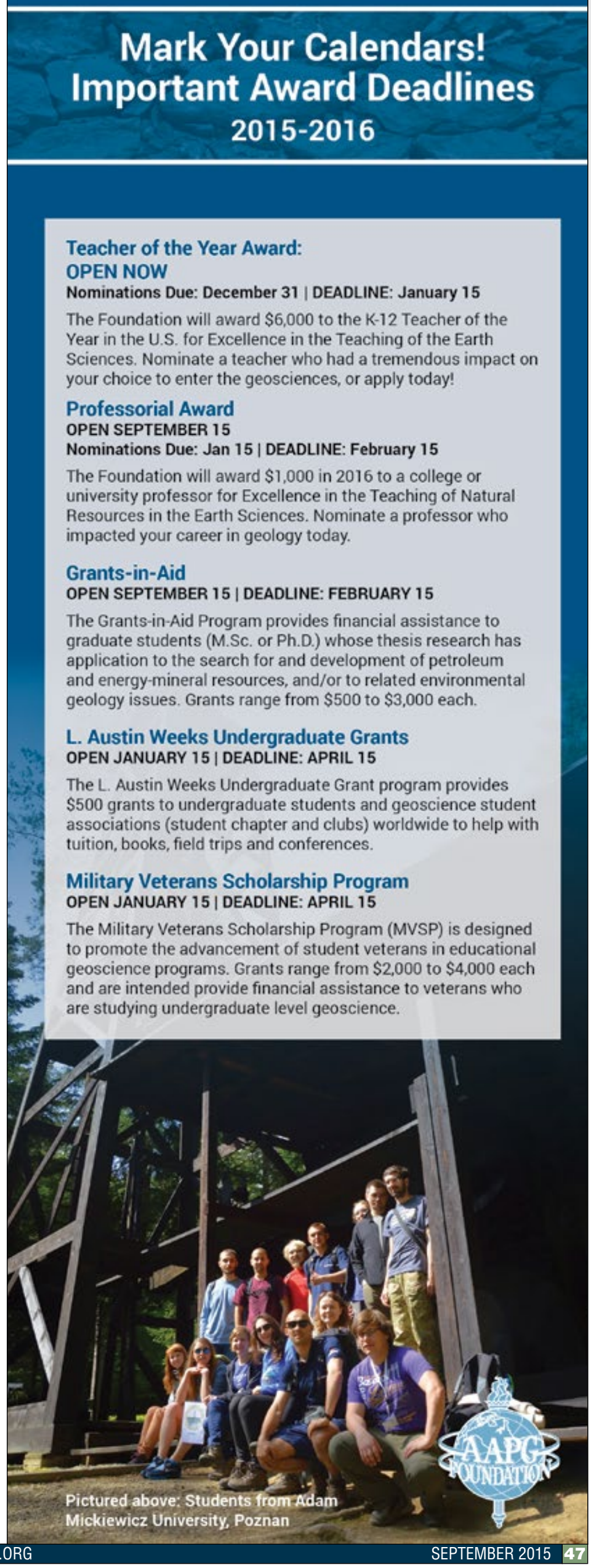

Pictured above: Students from Adam Mickiewicz University, Poznan

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

PROTRACKS

Is Technical Knowledge Enough To Survive Corporate Life?

By REETU RAGINI, Asia Pacific Region YP Leader


RAGINI

When I was student, I aspired to join a multi-national company with the best working culture.

We were told in school to work hard, study and gather as much knowledge as possible in order to do this. Knowledge was touted as one of the most important pillars of success in life. It's said that a knowledgeable person may outshine many of their colleagues with the skill and talent they bring to their corporate life.

As a new employee in a corporate work environment, one is faced with many new challenges.

Some of these challenges include the drive to succeed in a fast-paced environment, the desire to take advantage of the many opportunities that are available, and urge to prove that you are a consistently high performer.

It is important to remember that in order to overcome these challenges one must always keep learning, improving one's skills and developing new ones.

Knowledge alone does not make one successful in a corporate setting. There are a couple of simple things a new employee can do to complement their existing knowledge and set them on the path to a successful career.

New employees are sometimes overconfident and occasionally forget that there is still an incredible amount to learn.

Knowledge from your schooling is important, but new employees sometimes overlook the value of others' experience. That experience plays a vital role in the development of a new employee, especially in the petroleum industry.

Experience can come from seasoned professionals or other new employees with different backgrounds. There may be people who are not as technically strong as others initially, but over time, the experience they gain on the job strengthens and expands their knowledge base.

In order to be successful, one must use a combination of knowledge and experience. Sometimes we encounter individuals who are very technically skilled but cannot work well on a team.

This situation is easily spotted in today's corporate environment, where working in multi-disciplinary teams is commonplace.

While management might recognize the efforts of particular individuals, it is important to remember that the entire team, and the sum total of all team members' contributions, make a project successful.

The importance of collaboration, and the knowledge gained during that collaboration, cannot be understated. It is an essential resource in the oil and gas industry.

So, in a nutshell, I feel knowledge alone is not enough for a successful corporate career. One should cultivate other qualities that complement one's technical abilities. Knowledge and skill can help you get a job, but learning from experience and collaboration can help you build a career.

For additional career tips and resources, visit AAPG's Career Center at careercenter.aapg.org.

Improvements
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fine-grained sandstone at the base of the Fort Union Formation (Paleocene) and top of the Mesa Verde Formation (Upper Cretaceous).

This test used three 33-kiloton devices that were simultaneously detonated at respective depths of 5,838, 6,230 and 6,689 feet below the surface.

The concept at Rio Blanco worked to a degree in that the test created a chimney as designed. Gas production was initially enhanced, but experienced a 40 percent decline during testing.

Like the predecessor tests, the gas was too radioactive for use.

In view of the economic concern (estimates that 25 years would pay back 15 to 40 percent of investment) and environmental worries, Project Plowshare was discontinued.

Irreplaceable?

With experience and application of the learning curve, hydro-fracturing took off on a large scale – it was deemed safe and resulting production was free of radiation.

By 2012, over 57,000 wells in Kansas had been fractured since Stanolind's Klepper test in 1947. The U.S. Department of Energy has estimated that as of the year 2013, at least two million oil and/or gas wells have been hydraulic-fractured in the United States.

Improvement of horizontal drilling techniques first introduced in the 1930s combined with hydraulic fracturing has allowed development of tight formations and thinner producing zones. Incremental fracturing in long horizontal well bores has required new additives to fracturing fluid to compensate for natural petrologic variations.

Longer well bores require more liquid – a single horizontal fracturing operation in Kansas may call for more than two million gallons of water – a scarce product in some areas, not only in Kansas but worldwide.

Major worries concerning hydraulic fracturing as a source of earthquakes have caused public fear and additional politically inspired regulations and controls.

However, in order to meet increasing modern demands for energy, there seems to be nothing yet in view that will replace hydraulic fracturing. Wind and solar power are insufficient energy needs and fail to provide transportable energy, fusion – if ever attainable – is far in the future and the world's public fears nuclear power.

For the time being, hydraulic fracturing and drilling seems to provide the only achievable option.

And it began in Kansas.

(Editor's note: Lawrence Skelton is assistant director emeritus at the Kansas Geological Survey.)

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

CLASSIFIEDADS

POSITIONS WANTED

TENURE-TRACK APPLIED GEOSCIENCE, BAYLOR UNIVERSITY

Baylor University is a private Christian university and a nationally ranked research institution, consistently listed with highest honors among The Chronicle of Higher Education's "Great Colleges to Work For." Chartered in 1845 by the Republic of Texas through the efforts of Baptist pioneers, Baylor is the oldest continuously operating university in Texas. The university provides a vibrant campus community for over 15,000 students from all 50 states and more than 80 countries by blending interdisciplinary research with an international reputation for educational excellence and a faculty commitment to teaching and scholarship. Baylor is actively recruiting new faculty with a strong commitment to the classroom and an equally strong commitment to discovering new knowledge as we pursue our bold vision, Pro Futuris (www.baylor.edu/profuturis/).

Baylor seeks to fill the following tenure-track Assistant Professor faculty position within the Department of Geology with specialization in Geophysics, Stratigraphy or Structural Geology, beginning in August 2016. Candidates should possess an earned doctorate in geophysics or geology at the time of appointment. Preference will be given to a candidate with a strong background in pure or applied research who works with subsurface data (e.g., seismic, potential field, well log, rock property, fluid production, or combinations of these data types). The successful candidate should have the potential to attract external funds and to build a strong research program that involves both undergraduate and graduate (M.S. and Ph.D.) students. We seek an individual with a strong commitment to excellence in teaching at the graduate and undergraduate levels. Application Process: Send letter of interest, including statement of teaching and research interests, curriculum vitae, official transcripts, and the names and contact information for three references to: Dr. Jay Pulliam, Chair, Search Committee, Department of Geology, Baylor University, One Bear Place #97354, Waco, TX 76798-7354 (Tel: 254-710-2361; e-mail: appliedgeosci2016@baylor.edu). Applications will be reviewed beginning in September 2015 and applications will be accepted until the position is filled.

Baylor University is a private not-for-profit university affiliated with the Baptist General Convention of Texas. As an Affirmative Action/Equal Opportunity employer, Baylor is committed to compliance with all applicable anti-discrimination laws, including those regarding age, race, color, sex, national origin, marital status, pregnancy status, military service, genetic information, and disability. As a religious educational institution, Baylor is lawfully permitted to consider an applicant's religion as a selection criterion. Baylor encourages women, minorities, veterans and individuals with disabilities to apply.

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ASSISTANT PROFESSOR OF EARTH AND ATMOSPHERIC SCIENCES (Exploration Geophysics)

Applications are invited for a tenure track position as Assistant Professor in the Department of Earth and Atmospheric Sciences at the University of Nebraska-Lincoln. The successful candidate will be expected to participate in teaching and curricular development of undergraduate and graduate courses, to advise and direct graduate students, and to develop a rigorous research program that is supported by external funding. It is expected that the research program will include field and subsurface-based studies of exploration geophysics. Ability to contribute to growing petroleum geoscience-related teaching and research activities within the Department of Earth & Atmospheric Sciences will be considered as an advantage. The candidate should demonstrate strong potential for research and teaching and must hold a Ph.D. in Geology or a related field at the time of appointment. Female and ethnic minority candidates are strongly encouraged to apply.

The Sedimentary Geology and Paleontology, Meteorology/Climatology, and Hydrosphere Geosciences programs serve as the three primary units within the Department of Earth & Atmospheric Sciences. The department offers B.S. degrees in Geology and Meteorology/Climatology, as well as M.S. and Ph.D. degrees in Earth and Atmospheric Sciences. Additional information about our department can be found on our Web site: http://eas.unl.edu.

To apply, go to http://employment.unl.edu requisition 41016 and complete the "faculty/administrative form". Applicants must attach a cover letter, curriculum vitae, a statement detailing research and teaching interests, and names of at least three references via the above website. We will begin to review applications on November 5, 2014, but the position will remain open until it is filled.

The University of Nebraska is committed to a pluralistic campus community through affirmative action, equal opportunity, work-life balance, and dual careers. For further information, contact Dr. Chris Fielding, Search Committee Chair by email, phone, or mail at: cfielding2@unl.edu, 1-402-472-9801; Department of Earth & Atmospheric Sciences, University of Nebraska-Lincoln, 214 Bessey Hall, Lincoln NE 68588-0340.

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the oil business.

Check out the website: http://ipec.utulsa.edu/

* * *

So as Bruno Hanson challenged me, let me challenge you.

What do you care about?

What current or future environmental issues are important to you?

If knowing, understanding and working toward best practices of protecting our environmental resources is at all important to you, then you should be an active part of the DEG.

If you want to help in formulating policy statements or whitepapers, then let us know. We have just received approval for our white paper on Hydraulic Stimulation by the AAPG Executive Committee and it is available on the AAPG Wiki.

Now is the time, if you are not already a member, to come join us in the Division of Environmental Geosciences.

DIRECTOR'S CORNER

Fostering Community with TIGs and SIGs

By DAVID CURTISS

I'm an introvert.

Now, that may not be your first impression when watching me at one of our conventions or other events. There you'll likely find me among large groups of our members, smiling and engaging individuals in conversation, enjoying the energy of the crowd of people who are excited to be there. In fact, getting to know petroleum geoscientists from across the globe is one of the best aspects of serving in my role at AAPG.

But when I leave the reception I typically head back to my room for some quiet and solitude. As an introvert that is how I recharge.

My extrovert friends don't get this at all. Their energy levels go up as they circulate in the crowd. When the party is over they want to head to the bar to maintain those energy levels. Come on, just one more round …

Whether you are an introvert or extrovert doesn't really matter – it's simply how you're wired.

However, I've noticed that one aspect of my introversion leads to a tendency not to engage with people around me or to join groups, unless it's something I'm really interested in. And yet at many turns we hear about the importance of community to us as humans and professionals.

* * *

In his presidential address at the 2011 Annual Convention and Exhibition in Houston, then-president David Rensink talked about the fact that AAPG is a tribe, a tribe of geoscientists whose common focus is oil and natural gas.

Similarly last year, Randi Martinsen during her presidency emphasized the importance of community to each of us in this profession. It's one of the chief reasons AAPG exists.


CURTISS

> **In community you learn that you are not alone. That is particularly important in times like these, when many members of our community are finding themselves out of work due to the industry downturn.**

Whether referring to your family, tribe, association or nation, as humans we have organized ourselves in these various units to live and work. There are many benefits of being in community, which is why we develop them:

- **In community you learn the value of shared experience and expertise**.

That's certainly how AAPG seeks to advance the petroleum geosciences, by enabling you to learn from and teach other members of the community about what you know about finding oil and gas.

- **In community you learn the value of being less self-centered**.

When you volunteer to do something that benefits the entire community you may receive a tangible or intangible benefit. But even if you do not, your efforts contribute to strengthening the community and that benefits everyone.

- **In community you learn that you are not alone**.

That is particularly important in times like these, when many members of our community are finding themselves out of work due to the industry downturn. And as devastating as being caught in a lay-off can be, when you are connected to community you will have support to get back on track.

* * *

AAPG wants to foster community for its members. And at the 2015 Annual Convention and Exhibition in Denver, the AAPG House of Delegates voted to create a new classification of community: Technical Interest Groups (TIGs) and Special Interest Groups (SIGs).

These groups have a common purpose – to grow and deepen community with AAPG.

The TIGs will do this by focusing technical topics of interest and creating opportunities for AAPG members to engage with each other to address these topics. SIGs are similarly focused on fostering engagement of AAPG members on areas of common non-technical interest.

Last month the first two groups launched:

- The Mega-Giant Field Classification TIG will be looking to develop criteria for a new classification of large natural gas fields based on developments in the Marcellus and Utica shales. It's being chaired by AAPG members Greg Wrightstone and Bill Zagorski.
- The Young Professionals Membership Committee, under the leadership of Meredith Faber and Jonathan Allen, will be transitioning to become the first SIG. Its focus, as the name suggests, is the needs of young professionals and early career geoscientists.

This SIG will help members in this group connect to each other and the broader AAPG community.

Susan Nash, AAPG's director of Education and Professional Development, is coordinating this effort for us – and if you have a suggestion for a new TIG or SIG, please reach out to her through the AAPG website.

As Nash herself said, "together you have a chance to create something of lasting value – and also to share your insights and ideas."

We're already working to develop a series of processes and tools to help you get connected.

"The TIGs and SIGs," Nash continued, "will have the opportunity to put together articles, create sessions, propose research conferences and create educational materials."

* * *

So, what interests you?

It may be basin modeling or nano-scale fluid flow. Those could be new TIGs.

It may be golfing or fly-fishing. Those could be new SIGs.

Remember, the purpose is to weave ourselves into stronger community. It's essential for each of us – introverts and extroverts – to be connected in community as we navigate the turbulent times we're in.

Don't try to do this alone.

DIVISIONS REPORT: DEG

Care About the Environment? Join DEG

By JEFFREY B. ALDRICH, DEG President

"Don't you care about the environment?"

DEG's founder and first president – and an AAPG past president and legend – Bruno Hanson directly challenged me with that question.

He followed up with, "Most geologists that I know got into this profession by first having a love for the outdoors."

Some of those who knew Bruno were surprised that he was such an advocate for the Division of Environmental Geosciences, as Bruno was the consummate West Texas independent wildcatter. Yet, he was exactly right in understanding that we professional geologists have a passion for the outdoors and for maintaining the environment.

He asked me to consider joining the DEG and supporting its objectives. I became a founding member of the DEG, though I confess that through most of my career I stayed pretty removed from the profession of environmental geoscience.

That was until I became heavily involved in the operations of unconventional plays and I had to immerse myself in the environmental and societal impacts of unconventional development.


ALDRICH

> **If knowing, understanding and working toward best practices of protecting our environmental resources is at all important to you, then you should be an active part of the DEG.**

* * *

This year I am honored and humbled to take on the role of president of the DEG after immersing myself this past year as president-elect under the superb leadership of Jeff Paine, last year's president, and the entire Executive Committee. I want to welcome the new DEG Executive Committee:

- ❒ **Bruce Smith** – vice president.
- ❒ **Tim Murin** – president-elect.
- ❒ **Sean Kimiagar** – secretary-treasurer.
- ❒ **Michelle Cooney** – editor.
- ❒ **Jeff Paine** – past president.

Paine encouraged us to be more proactive and less reactive when it comes to environmental issues. To that end, the DEG has several new initiatives that I think you will find exciting.

- The first is to create a connection with every AAPG member, whether they currently are a DEG member or not – and to that end we have recharged the DEG Advisory Board and now have excellent representation for every AAPG Section and Region.

This means that wherever you are, you have a direct contact and representative to the DEG leadership team. Their names and contacts are on our new website, so please connect with them.

The Advisory Board will tackle some of our larger issues from the depths of their global expertise and suggest courses of action for our Executive Committee to enact.

- Second, we have redesigned the DEG website to make it more interactive and to keep current information of use to all AAPG members on the site.

Be sure to check it out. There is now a DEG Blog, updated information on events of interest and extra information on the "member's only" portion of the site for DEG members.

The Environmental Division does require a small dues payment as we do publish a separate peer-reviewed journal, "Environmental Geosciences," with excellent articles under the stewardship of Michelle Cooney. I will talk more about this great publication in future columns.

- Third, there will be greater DEG content and participation at Section and Region meetings, and we already are well under way with the environmental programs for the Melbourne ICE and next year's Calgary ACE. Look for the Call for Abstracts and be sure to submit an oral or poster presentation.

We also have lent our endorsement to the 22nd IPEC Conference in Denver this November. The Integrated Petroleum Environmental Consortium (IPEC) is an academic consortium dedicated to finding low-cost solutions to environmental challenges facing independent producers in

See **DEG**, page 49

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