AAPG EXPLORER
OCTOBER 2010

Action in the North Atlantic

Shooting seismic – and waves – near Greenland

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AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS AN INTERNATIONAL ORGANIZATION

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OCTOBER 2010

AAPG EXPLORER

PRESIDENT'S COLUMN

GOM Operations Enter New Era

By DAVID G. RENSINK

BP's Macondo well has been plugged using top-kill techniques, and the oil on the surface of the Gulf of Mexico is dissipating faster than many had predicted. The oil flow has stopped and the well has been sealed. This is very good news.

You probably have heard all that you want to hear about this tragedy, but the collateral effects of the blowout are not over by any means.

BP has retrieved the blowout preventer stack (BOP) and, we can all hope, has determined why the last line of defense did not work.

The surface analysis of the BOP failure may prompt design changes in the BOP system, but it almost certainly will lead to new regulations on testing, maintenance and composition of the blowout preventer stacks in both deep and shallow water. We can expect to see any proposed changes for the Gulf of Mexico ultimately implemented worldwide.

I hope this catastrophe will be as close to a worst-case scenario as we will ever see.

As unfortunate as this has been, it has created a laboratory from which we will be able to answer two questions we were only able to speculate about previously:

- What are the long-term effects of such a catastrophe?
- How quickly will the ecosystem recover?

The answers to these questions will have great impact on future environmental assessment requirements for leasing.

The catastrophe also has raised questions regarding our ability to respond quickly and effectively to the pollution caused by a major oil blowout in the Gulf of Mexico. It probably is more correct to say that it has exposed our inability to effectively respond to a spill of this magnitude.


RENSINK

As unfortunate as Macondo has been, it has created a laboratory from which we will be able to answer questions we were only able to speculate about previously.

Chevron, ConocoPhillips, ExxonMobil and Shell should be commended on their plans to deploy a rapid response system to contain oil from any future blowout.

The moratorium on GOM deepwater drilling made sense immediately after the Macondo blowout while safety inspections were conducted. It makes less sense to carry it through to its November termination, since any safety deficiencies discovered have been corrected (see Washington Watch, page 44). The administration has stated the moratorium will not last a day longer than it deems necessary.

Even in November, there is no guarantee that the moratorium will not be extended; nor is there any certainty that new drilling permits will be issued in a reasonable time frame after the moratorium expires for drilling to resume quickly.

Based on the observations that very few deepwater rigs have left the Gulf of Mexico for international assignments and the changes in international rig counts have been minor, the GOM deepwater moratorium seems to have had a global impact. That likely is an over simplification. Most GOM operators and drilling companies have taken a wait and see attitude, and the decision to deploy their resources to international deepwater basins may not be made until later this year.

The issuance of few drilling permits for new locations on the GOM shelf since the blowout has essentially created a de facto drilling moratorium in the entire Gulf of Mexico. Operators report the only drilling permits currently being issued are those that involve sidetracking existing well bores.

This premise of a de facto moratorium is re-enforced by the cancellation of the western GOM lease sale originally scheduled for August.

In addition, there no longer is any support for leasing in the eastern GOM, off the Atlantic coast or off the California coast.

The spill is history and so is easy access to public lands – at least in the near term. Many of you would argue that we have never had "easy access" to public lands. That may be true, but whatever level of access existed in the past has gotten more difficult.

President Dave Rensink, speaking at the recent AAPG International Conference and Exhibition in Calgary. About 2,300 people registered. Watch the November EXPLORER for a full report.

STAFF

AAPG Headquarters:
1-800-364-2274 (U.S. & Canada only),
others 1-918-584-2555

Communications Director
Larry Nation
e-mail: lnation@aapg.org

Managing Editor
Vern Stefanic
e-mail: vstefan@aapg.org

Communications Project Specialist
Susie Moore
e-mail: smoore@aapg.org

Correspondents
David Brown
Louise S. Durham
Barry Friedman

Graphics/Production
Matt Randolph
e-mail: mrandolph@aapg.org

Advertising Coordinator
Brenda Merideth
P.O. Box 979
Tulsa, Okla. 74101
telephone: (918) 560-2647
(U.S. and Canada only:
1-800-288-7636)
(Note: The above number is
for advertising purposes only.)
fax: (918) 560-2636
e-mail: bmer@aapg.org

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REGULAR DEPARTMENTS

ON THE COVER:

Seismic crews are keeping busy around the world – a fact documented by the numerous stories in this month's annual Geophysical Review issue of the EXPLORER. The cover shot captures the danger and excitement of exploring offshore West Greenland; the photo to the left captures the potential for paradise – the kind being sought offshore the Andamen Islands in the Indian Ocean (see page 40) – where seismic crews also are active. Cover photo courtesy of PGS.

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AAPG awardees to be honored in Houston

Shelton Named Powers Medalist

Professor, researcher and visionary geologist John W. Shelton has been awarded the 2011 recipient of AAPG's highest honor, the Sidney Powers Medal.

Joining Shelton at the top of this year's awardees list is Daniel L. Smith, exploration vice president for Sandalwood Oil and Gas and independent geologist in Houston, who will receive the Michel T. Halbouty Outstanding Leadership Award.

Shelton and Smith are among the 42 award winners who have been announced by AAPG and who will be recognized at the opening session of the 2011 AAPG Annual Convention and Exhibition April 10-13 in Houston.

AAPG awards, approved by the Executive Committee, are presented annually to recognize individuals for service to the profession, the science, the Association and the public.

Among Shelton's achievements over his career is his foresight in the early 1990s to plan and implement AAPG Datapages, the Association's digital library and publishing program. His leadership continued the growth in the digital library, and an award is in his name that recognizes the best contribution to the *Search and Discovery* website over the year.

Shelton was an early developer of the concepts and application of sedimentary petrology and depositional environments to petroleum exploration, and at Shell Research was among the pioneers in applying depositional environments to prospect definition.

He had a 20-year career as a professor at Oklahoma State University, mentoring many of his master's students to distinguished careers.

Working with ERICO and later Masera, Shelton also was a pioneer in the concept of multi-client studies and took lead roles as both director and contributor on major projects in the North Sea, North Africa, the Mediterranean, Africa and China.


SHELTON


SMITH

Smith is the fifth recipient of the Halbouty Outstanding Leadership Award, given in recognition of outstanding and exceptional leadership in the petroleum geosciences.

Interviews with both Shelton and Smith will be published in a future EXPLORER, and biographies and citations of all award winners will be included in a future BULLETIN.

Award winners announced by AAPG and who will be honored along with Shelton and Smith in Houston are:

Honorary Member Award

Presented to members who have distinguished themselves by their accomplishments and through their service to the profession of petroleum geology and to AAPG.

❒ **Steven L. Veal**, DCX Resources, London, England.

❒ **Charles A. Sternbach**, Star Creek Energy, Houston.

❒ **R. Randy Ray**, R-3 Exploration, Lakewood, Colo.

❒ **Robert L. Countryman**, Bakersfield, Calif.

❒ **Barry J. Katz**, Chevron, Houston.

Outstanding Explorer Award

Presented to members in recognition of distinguished and outstanding achievement in exploration for petroleum or mineral resources, with an intended emphasis on recent discovery.

❒ **Douglas K. Strickland**, Jayden Consulting, Oklahoma City.

Strickland is the principle discoverer of the Covenant Field in Sevier County, Utah, the initial discovery within the central Utah Overthrust Belt.

Robert R. Berg Outstanding Research Award

AAPG's newest award, presented to honor a singular achievement in petroleum geoscience research.

❒ **Ole Jacob Martinsen**, Statoil ASA, Bergen, Norway.

Martinsen, the head of exploration research at StatoilHydro, is widely regarded as one of the key geoscientists in northwest Europe.

Distinguished Service Award

Presented to those who have distinguished themselves in singular and beneficial long-term service to AAPG.

❒ **Gretchen M. Gillis**, Schlumberger, Houston.

❒ **Gina B. Godfrey**, PetroWeb, Denver.

❒ **W.C. "Rusty" Riese**, BP Alternative Energy, Houston.

❒ **Sigrunn Johnsen**, RWE Dea Norge AS, Oslo, Norway.

❒ **Herman Darman**, Shell International E&P, Rijswijk, Netherlands.

❒ **Rick L. Ericksen**, Mississippi State Board of Registered Professional Geologists, Jackson, Miss.

❒ **Deborah E. Ajakaiye**, Houston.

❒ **John E. Ritter**, Occidental Petroleum, Houston.

Grover E. Murray Distinguished Educator Award

Presented for distinguished and outstanding contributions to geological education, both at the university level and toward education of the general public.

❒ **Lawrence D. Meckel**, L.D. Meckel and Company, Denver, honored for a long teaching and training career for both companies and schools, largely at the Colorado School of Mines.

❒ **Ronald J. Steel**, University of Texas at Austin, Austin, Texas.

Steel is both professor and David Centennial Chair at the University of Texas

See **Awardees**, page 6

Awardees
from page 4

at Austin, and Sixth-Century Chair of Sedimentary Geology at the University of Aberdeen, Scotland.

Special Award

Presented to individuals and organizations whose area of work may not qualify for one of the existing awards, but is worthy of Association recognition.

❒ **Anthony Doré**, Statoil, Houston.

One of the most influential, honored and recognized geologists living in Russia, Kontorovich has had a profound impact on the mapping and assessment of oil and gas reserves in most Russian basins.

❒ **Myron K. "Mike" Horn**, M.K. Horn and Associates, Tulsa.

Horn, an AAPG Honorary Member, has developed four global databases that are significant parts of the GIS-UDRIL project.

Public Service Award

Presented to recognize contributions of AAPG members to public affairs – and intended to encourage such activities.

❒ **Mark J. Doelger**, Barlow and Haun, Casper, Wyo., for promoting geosciences in the public and at schools, including his efforts to have a U.S. Geological Survey Time and Terrain Map of the United States mounted prominently in south Texas schools.

Pioneer Award

Presented to long-standing members who have contributed to the Association and who have made meaningful contributions to the science of geology.

❒ **J. Myles Bowen**, retired (Shell), Newton Abbot, England.

Bowen had a long and successful career as the leader of exploration teams, working (and scoring discoveries) in Venezuela, Nigeria, the North Sea (as leader of Shell Expro) and Italy, among other ventures.

❒ **John Wold**, Wold Oil and Gas, Casper, Wyo.

Wold, an AAPG Public Service Award winner, has had a long and successful career as a geologist and civic leader in Wyoming. Also, in 1969 he became the first professional geologist to serve in the U.S. House of Representatives.

Wallace E. Pratt Memorial Award

Presented to the author(s) of the best AAPG BULLETIN article published each calendar year.

❒ **William A. Ambrose**, **Tucker F. Hentz**, **Florence Bonnaffe**, **Robert G. Loucks**, **L. Frank Brown Jr.**, **Fred P. Wang** and **Eric C. Potter**, for "Sequence-Stratigraphic Controls on Complex Reservoir Architecture of Highstand Fluvial-Dominated Deltaic Lowstand Valley-Fill Deposits in the Upper Cretaceous (Cenomanian) Woodbine Group, East Texas Field: Regional and Local Perspectives," which appeared in the February 2009 BULLETIN.

All are with Bureau of Economic Geology at the University of Texas at Austin, Texas.

Robert H. Dott Sr. Memorial Award

Presented to the author/editor of the best special publication dealing with geology published by the Association.

❒ **Claudio Bartolini** and **J.R. Román Ramos**, for Memoir 90, *Petroleum Systems in the Southern Gulf of Mexico*.

Bartolini is with Repsol, Madrid, Spain, and Ramos is with Pemex, Mexico City, Mexico.

J.C. "Cam" Sproule Memorial Award

Presented to younger authors of papers applicable to petroleum geology.

❒ **David M. Dutton** and **Bruce D. Trudgill**, for the paper "Four-Dimensional Analysis of the Sembo Relay System, Offshore Angola: Implications for Fault Growth in Salt-Detached Settings."

Dutton is with Nexen Petroleum, Woking, England. Trudgill is with the Colorado School of Mines, Golden, Colo.

John W. Shelton Search and Discovery Award

Presented to the author(s) of the best contribution to the Search and Discovery website in the past year.

❒ **Dwight M. "Clint" Moore** and **Robert O. Brooks**, for the article "The Evolving Exploration of the Subsalt Play in the Offshore Gulf of Mexico."

Moore is with ION Geophysical, Houston, and Brooks is retired from TGS, Garland, Texas.

George C. Matson Award

Presented to the best oral presentation at the 2010 AAPG Annual Convention and Exhibition in New Orleans.

❒ **Satinder Chopra**, for the paper "Detecting Stratigraphic Features via Cross-Plotting of Seismic Discontinuity Attributes and Their Volume Visualization."

Chopra is with Arcis, Calgary, Canada. His co-author is Kurt J. Marfurt, with the ConocoPhillips School of Geology and Geophysics at the University of Oklahoma, Norman, Okla.

Jules Braunstein Memorial Award

Presented to the best poster presentation at the 2010 AAPG Annual Convention and Exhibition in New Orleans.

❒ **Eddy Lee**, **Craig Shipp**, **Willem Hack**, **J. Larry Gibson** and **Fa Dwan** for the poster "Quantifying the Probability of Occurrence of Shallow Gas as a Geohazard."

AAPG members Lee, Shipp and Gibson are with Shell International E&P, Houston, and AAPG member Dwan is with Shell E&P Technology, Houston. Hack is with Shell International E&P, Houston.

Geosciences in the Media Award

Presented for notable journalistic achievement that contributes to public understanding of geology, energy resources or the technology of oil and gas exploration. Granting of this award in any year is discretionary.

❒ **Ronald C. Blakey**, for the significant contribution of his website. Blakey is professor of geology at Northern Arizona University, Flagstaff, Ariz.

❒ **Tom Zoellner**, for his book "Uranium." Zoellner is a professional journalist and lives in Hanover, N.H.

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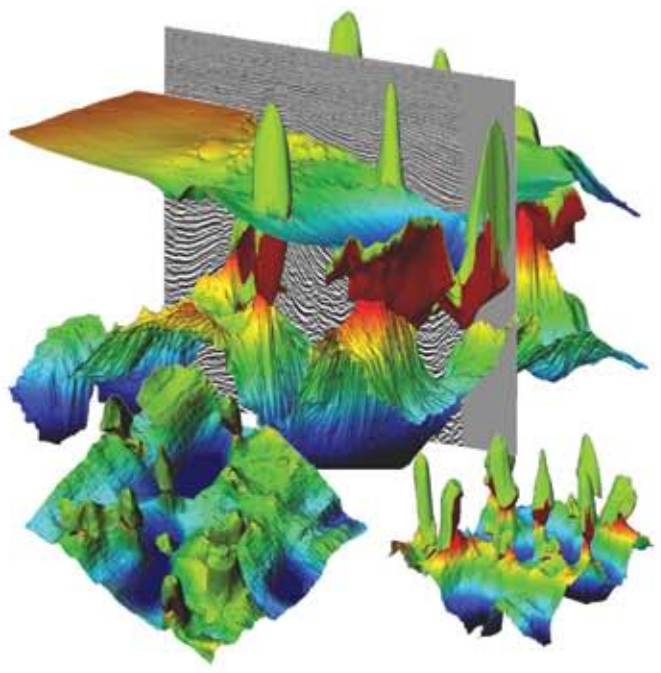

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SYSTEMS ACQUISITION LICENSING PROCESSING IMAGING

GOM a downer for now, though

Seismic Seeing Uptick in Demand

By LOUISE S. DURHAM, EXPLORER Correspondent

Is that light at the end of the geophysical tunnel getting brighter?

Maybe so. The consensus of many participants in the seismic business is that activity levels are looking fairly respectable these days.

"One thing people are saying is the seismic industry has sort of bottomed out," said Gregg Parker, senior VP of corporate marketing at PGS. "It's been through a downturn and coming up."

AAPG member Robert Hobbs, CEO at TGS, concurred.

"Seismic in general is positive," he said. "We're still seeing a recovery based on oil companies return to investing in exploration versus where we were in late '08 and early '09."

The uptick appears to be widespread, according to Bob Peebler, CEO at ION Geophysical.

"From a macro perspective, we see activity picking up not only in North America but also many markets around the world, in places such as Russia and the Middle East," Peebler said. "It's not a strong market, but it's better and it's improving.

"There's still enough uncertainty in the global economy that we don't think people are clinking their champagne glasses," he noted. "They're still cautious.

"We think the market should be stronger in 2011, barring the economy going back in the ditch completely," Peebler added.

Sounds reasonably rosy.

But there are thorns, particularly in the marine side of the business.

Think Gulf of Mexico drilling moratorium resulting from The Big Spill.

"Most people, both on the customer and service side, are all kind of waiting to see what develops in terms of regulation from the U.S. government," TGS' Hobbs said. "There's concern of what's going to happen from a regulatory standpoint and, as a result, who will play, who will be able to play.

"We make our investment decisions on the number of customers we think might be interested in investing in new projects," Hobbs continued. "So we're waiting along with everyone else to see who those will be."

TGS uses a business model that entails putting together multi-client projects and then chartering other companies to acquire the data. Hobbs emphasized there's no concern over investments already made in the Gulf, and the most recent one is ahead of schedule in terms of sales.

John Walsh, VP of corporate marketing at PGS, which currently has no GOM surveys in progress or planned, noted that the moratorium has slowed the decision-making process among customers who are awaiting the outcome.

"There's a slowdown at the moment, but it also could have a knock-on effect in 2011," Walsh cautioned.

"The way the multi-client business works is you shoot a survey, and at some point you spend a few months processing and sell it the following year," Parker said. "If companies aren't able to shoot at present, then they can't process over the winter to be able to sell in 2011."

Questions in the Gulf

A potential upside stemming from the present conundrum for the data folks and others is that customers may place more value on the benefits of high resolution seismic in planning and implementing drilling/exploration programs, according to Parker.

No one is predicting the Gulf will once again revert to its Dead Sea status of a number of years ago.

It's too valuable.

"For the most part, everybody recognizes that the Gulf of Mexico is still going to be very important for hydrocarbon production," Hobbs emphasized. "There's no doubt about that in the long term or even medium term."

While there's justified hand-wringing over who has the staying power to deal with the increased costs and stringent – maybe near-impossible – rules and regulations expected to come down the pike, the drillers and seismic companies both have other challenges to overcome in the Gulf as well.

For example, there's litigation focused on the federal government's reported violation of the Marine Mammal Protection Act and the Endangered Species Act.

"This is a big deal now for deep and shallow water," said Joe Dryer, VP of data licensing at FairfieldNodal. "Several groups, including the Center for Biological Diversity, are suing the government for ignoring the marine mammal protection laws.

"The lawsuit is aimed at the overall industry, not just seismic," Dryer emphasized. "It's getting a lot of attention now."

The center filed a formal notice of intent to sue May 14, 2010. At press time, the group had not filed the actual lawsuit.

The organization reportedly accused the Department of the Interior, under Secretary Ken Salazar's watch, of approving three lease sales, more then 100 seismic surveys and more than 300 drilling operations without authorizations required by the protection laws.

Among many other grievances, there are long-standing complaints by environmental groups that noise generated via seismic and drilling activity is harmful to the mammals in numerous ways, e.g., potentially interfering with their communications.

Global Activities

Despite some of the dark clouds hovering over the industry, the sunshine does peek through.

There's buzz making the rounds that some non-Gulf players are contemplating the potential benefits of partnerships from companies mainly focused on the Gulf and now looking elsewhere. This could be quite beneficial for the players having other areas to work.

There are plenty of these areas, and the seismic folks are right there.

"PGS is marine-focused from an acquisition standpoint," Parker said. "We have vessels worldwide, including the North Sea, West Africa, Brazil, Asia Pacific.

"In fact, Asia Pacific is growing for us at the moment," he noted. "We've moved some of our new technology into the region."

TGS has announced several large pre-funded 3-D surveys in northwest Europe and West Africa.

Hobbs noted they also have a large 2-D survey that covers all major basins offshore Brazil.

"When we go into a basin, we acquire regional 2-D data and often go back for 3-D," he said. "We look to continue investing in Brazil; it's been a good area for us."

Brazil has long been alluring to the industry, even more so now with all the pre-salt action and new production.

"We have a long-term contract with Brazil, and have had more than one vessel there over the course of two years," Parker said.

The company has been working Brazil for about 15 years and has one of the largest of its 20 data processing centers located there. In fact, the processing center in Rio de Janeiro is going into a large upgrade due to back orders, and the company has been awarded a fiber optic fixed installation project at Jubarte Field in the Campos Basin offshore Brazil.

The marine business needs to undergo a slim-down of sorts.

"There's still over-capacity in our industry," Walsh said, "and that could hurt some companies."

TGS' Hobbs agreed.

"The marine industry is still oversupplied," he said. "It will take a while for seismic demand to match what new capacity the industry brought out recently."

He noted that the mid-year E&P surveys are encouraging for the seismic industry.

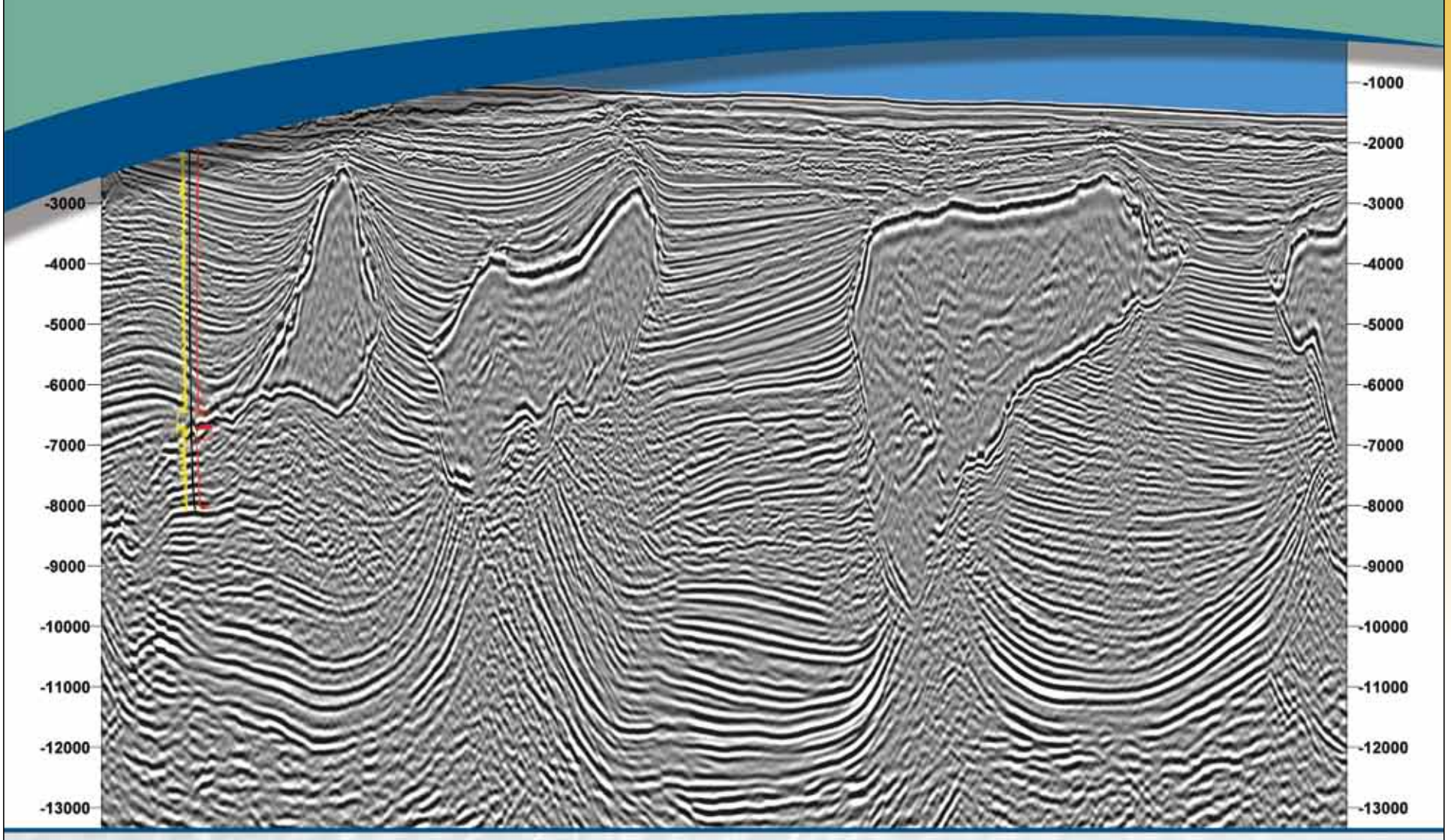
"There don't appear to be significant reductions in E&P spending this year," he said. "This tells me there's quite a bit of money left to invest in exploration this year, especially when you recognize it's not being invested in the deepwater Gulf of Mexico now.

"If not there, it's going to be spent elsewhere like frontier basins outside the U.S.," Hobbs predicted.

Photos courtesy of PGS

Though the seismic industry has been through some tough times, recent trends suggest a cautious return to a more active era and a more positive mood across the profession.

Sound Images with WAZ



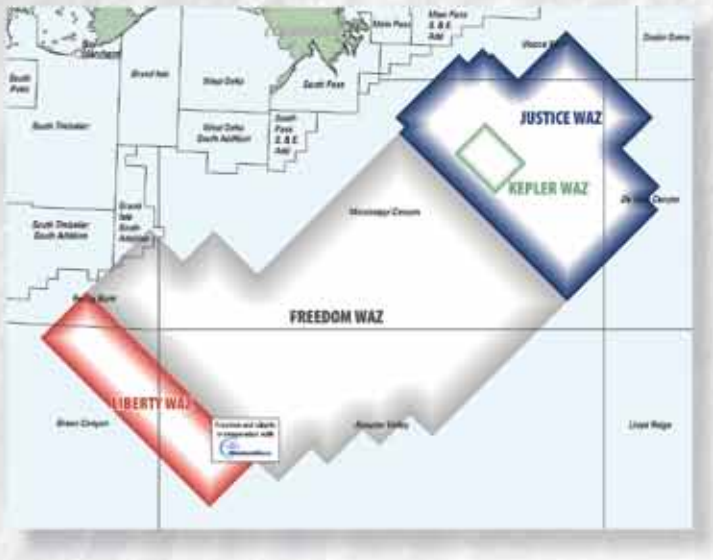


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Photo courtesy of WesternGeco

Land seismic operations are seeing an uptick, too, thanks in part to the rise of shale gas plays.

A trend toward multi-client shoots

Shale Plays Prop Land Seismic Action

By LOUISE S. DURHAM, EXPLORER Correspondent

Land seismic is a whole different world from marine, and it's experiencing its own uptick owing in large part to the proliferation of shale gas plays in the United States.

These plays have become so ubiquitous – and productive – that natural gas storage is over the top, while prices are virtually on life support.

This is bad and yet, in a way, not so bad.

"When prices were at $14, you could almost drill anything, and the economics would work," commented Bob Peebler, CEO at ION Geophysical. "Once prices drop, you have to look for ways to be more productive, whether in drilling wells or completing the ones you're drilling more accurately."

The ongoing anemic natural gas price, hovering around $4/Mcf on a good day, has prompted many players to head toward shale oil plays along with shale gas plays that have a significant liquids component.

No matter the type of production, seismic data info has become a necessity not just to try to zero in on the sweet spots but to efficiently wrest the hydrocarbons from the dense shales.

"One of the themes we're talking about at conferences is understanding plumbing of these reservoirs," said Steve Trammel, senior product manager at IHS in Denver.

"In the 1980s, when we were drilling horizontal in the Bakken and the play fizzled," Trammel said, "we were saying unconventional meant uneconomical.

"In the late 1990s and 2000s, technology such as extended reach horizontal drilling, and multi-stage fracing combined with 3-D enabled greater understanding of these reservoirs," Trammel noted.

He emphasized that seismic data are important owing to so much variability of reservoir quality in the shales.

"When you use 3-D in these resource plays, it gives you a view of the petrophysical and geomechanical properties of those reservoirs to better predict where most of the production zones are for the drill bit and for fracing the well," Trammel noted.

"Three-D also helps to identify where the fracture swarms are, where the fracture density really is," he added. "Also, it tells you the orientation of the fracture matrix, which helps to determine the most effective drilling direction."

Trends

Peebler emphasized there's significant interest in geology and geophysics.

"I think people are going back and looking at how to do more detailed geophysics and geology work and integrate it with the engineering and be more precise," he said.

"We're more at the beginning of that than the end," he noted. "People are still struggling to completely understand some of the workings of these reservoirs."

Peebler noted also that they're seeing a trend toward more multi-client seismic surveys in the shales than proprietary shoots, which is a sensible approach given these are large areas with a lot of players.

Global Geophysical Services, which is seemingly everywhere acquiring seismic data in the shale plays these days, is big on multi-client programs.

"The bulk of our shale work is multi-client," said AAPG member Richard Degner, president at Global. "There's a huge economy of scale with these continuous reservoirs to record at scale over large areas and to have seamless contiguous datasets.

"The multi-client business model lends itself favorably to those areas," Degner emphasized. "We acquire very high resolution, or reservoir grade 3-D (RG3D®), which is important to optimize what are six to eight million-dollar wells and completions."

A non-seismic trend drawing attention in the shale arena is "the big fish swallowing the little fish," according to Peebler.

A notable example is ExxonMobil's

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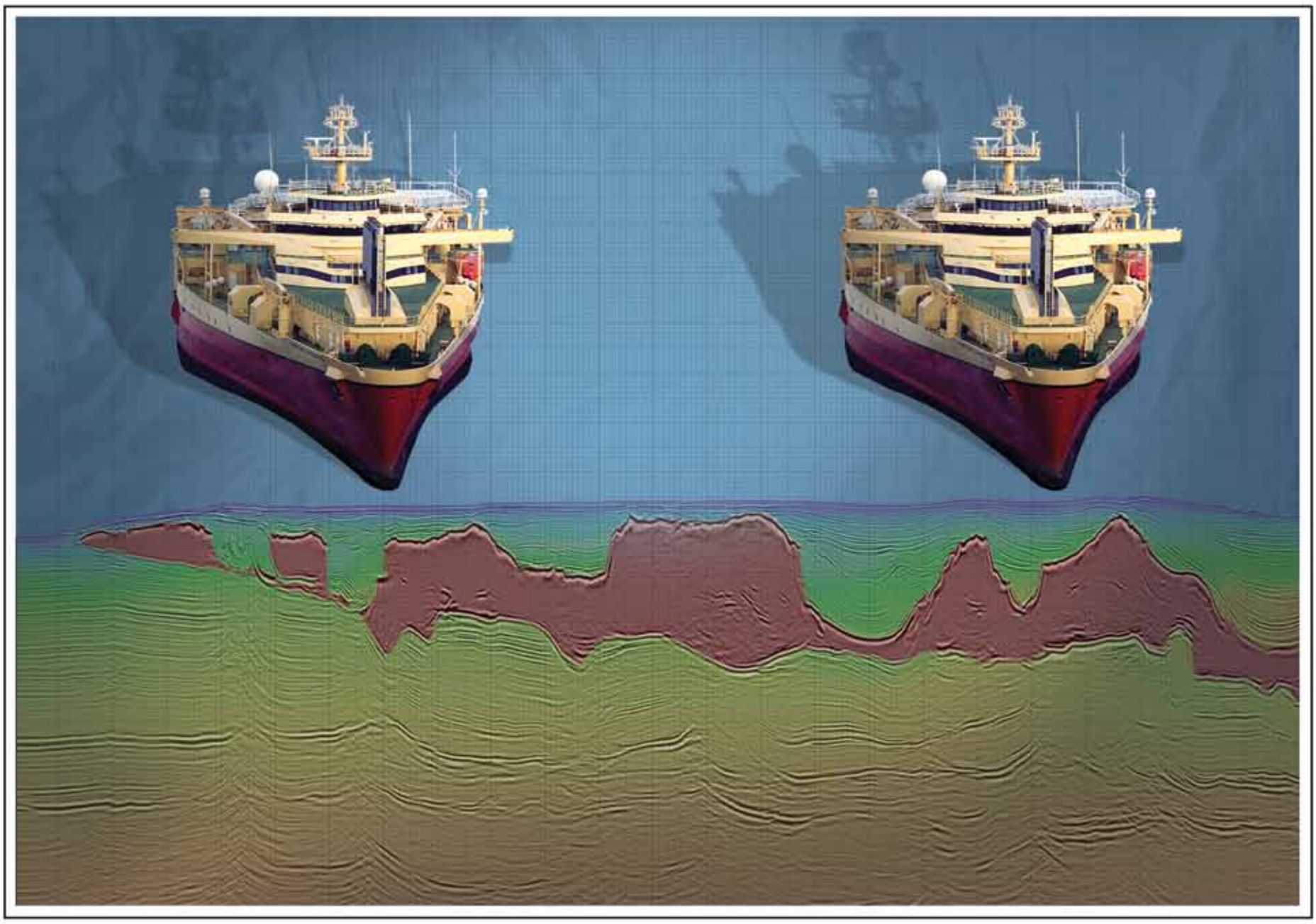
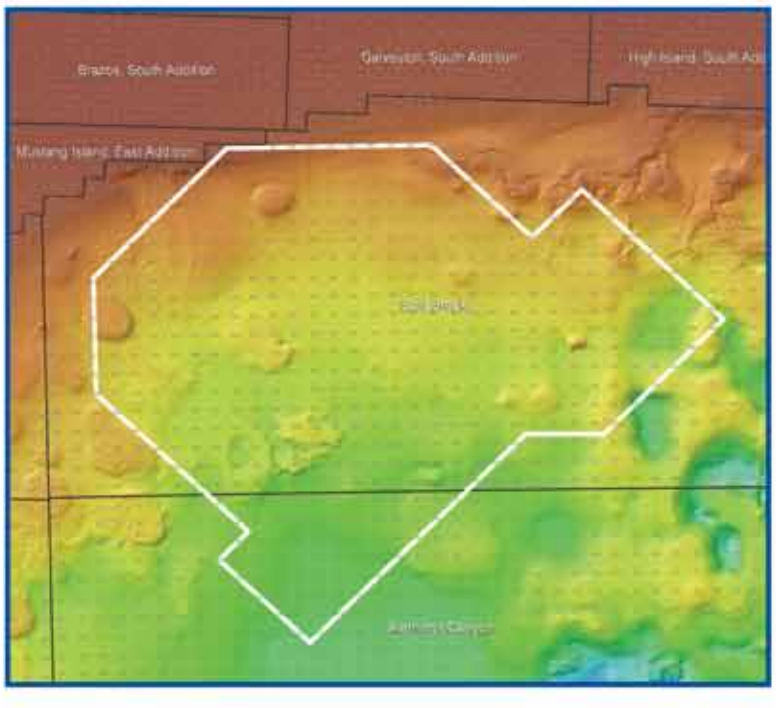


Crystal III, East Breaks

MultiClient Wide Azimuth



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A number of implications

Yes, Virginia, There Is Induced Seismicity

By DAVID BROWN, EXPLORER Correspondent

Maybe it will catch on as a new saying: *Induced seismicity happens.* Science is still working to understand how and why earthquakes can be induced by human activity. But scientists studying the phenomenon have no doubt that induced seismicity occurs.

This has a number of implications for the energy industry, including oil and gas exploration.

"Before 1950, induced earthquakes were like extra-sensory perception and little green men. Nobody believed they existed," said Cliff Frohlich, senior research scientist and associate director of the Institute for Geophysics at the University of Texas at Austin.

"Although that's not entirely true," he added, "because when they built the hydroelectric dam by the Grand Canyon, they induced some earthquakes."

Induced seismicity began drawing more attention in the early 1960s. The U.S. Army drilled a 12,000-foot disposal well at its Rocky Mountain Arsenal near Denver and began injecting fluid in 1962.

In the following years, almost 1,500 earthquakes occurred in the area. Most were small, many not even noticeable by the local population, but the largest was a magnitude 5.0 on the Richter scale. It shook both Denver and Boulder.

"By the late 1960s to early 1970s in my business," Frohlich recalled, "it was established that this kind of thing can happen."

What's Shaking? Maybe More Than You'd Guess

Besides the recent attention that has been focused on oil and gas, geothermal and potential CO_2 sequestration sites, there are other areas prone to produce induced seismicity.

They include:

- **Reservoir impoundment** (water behind dams).

"Almost all of the significant (recorded activity and in some cases felt activity) is associated with shear failure. These types of earthquakes can be very small or large depending on the geologic environment and available forces to cause an earthquake," according to the DOE's Lawrence Berkeley National Laboratory.

- **Mining** (creating cavities in the subsurface) also cause shear failure along planes of weakness – but that is usually due to relieving stress or subsidence, according to the laboratory.

- **Tall Buildings.**

According to a National Taiwan Normal University study published in the Geophysical Research Letters, the stress from the 508-meter Taipei 101 skyscraper may have reopened an ancient earthquake fault and caused tremors in a previously stable area.

On the other hand, it also has been described as a "pinprick" on the Earth and insignificant on its effect.

Pressure Points

Scientists have recorded numerous surface seismic events related to water injection for geothermal energy projects.

For example, repeated quakes have occurred around The Geysers, the world's largest complex of geothermal plants in an earthquake-prone area north of San Francisco.

Injections at the Hot-Dry-Rock (HDR) enhanced geothermal project at Basel, Switzerland, caused a series of small quakes in late 2006 and early 2007. After a three-year study, the Basel HDR project was cancelled.

"There's been renewed interest in induced earthquakes over the past few years, for practical reasons," Frohlich observed.

He identified three areas of concern:

- **Geothermal energy**. Enhanced geothermal systems incorporate high-pressure water injection.
- **Unconventional gas**. Shale gas development in particular relies on hydraulic fracturing and requires wastewater disposal.
- **Carbon sequestration**. Plans for carbon sequestration include pumping and storing supercritical – liquid – carbon dioxide deep underground.

Most induced seismicity appears to result from activities that alter pore pressure in areas with faults already under stress.

"If you force fluids into it, that 'unlocks' the fault. These fluids can be water or wastewater, or other stuff, but the most common is water," Frohlich said.

"Studies show that most crustal rock is under stress, and if there are little faults there, they can sometimes shift if fluids reach them," he noted.

Other activities can alter the subsurface and lead to measurable quakes. That includes production activity.

"There have been fields where very shallow earthquakes occurred within or near the fields, where people were pumping out liquids instead of injecting them," Frohlich said.

Getting the Fracs Right

The Earth Sciences Division of the U.S. Department of Energy's Lawrence Berkeley National Laboratory has conducted studies into and held workshops about induced seismicity.

Most of the existing research centers on geothermal operations, although Lawrence Berkeley noted "induced seismicity in oil and gas production has

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been observed since the 1930s."

To date, hydraulic fracturing by the oil and gas industry hasn't resulted in reported surface earthquake events.

Induced seismicity includes shear and tensile seismicity. When induced events have been significant, they've been related to shear failure.

Hydraulic fracturing is a short-term, high-pressure process designed to create tensile failure, to cause fractures by what is sometimes called a "mini-earthquake." Frac activities for natural gas production haven't caused detectable surface quakes.

"To our knowledge hydrofracturing to intentionally create permeability rarely creates unwanted induced seismicity large enough to be detected on the surface with very sensitive sensors, let alone be a hazard or annoyance," a Lawrence Berkeley report commented.

But enhanced geothermal operations also use hydraulic fracturing techniques, and those sometimes have resulted in induced seismicity. And some studies have found detectable shear motion in a rock tensile failure process.

Frohlich noted that operators wouldn't want to conduct a frac operation in an area where conditions could likely negate the effect of the hydraulic pressure.

"If the model is there's a fault that's likely to slip, you wouldn't want to lose the liquids," he said.

Barnett Case Study

Wastewater and brine disposal is more a concern for the industry.

In 2008, residents of the Dallas-Fort Worth area reported a series of small but noticeable ground quakes. Some residents wondered if activity related to Barnett Shale drilling and production caused those events.

Frohlich and AAPG member Eric Potter from the University of Texas and Brian Stump and Chris Hayward from Southern Methodist University in Dallas studied the quakes and wrote a case study paper published earlier this year.

They found that the quakes could have been induced seismicity related to saltwater disposal activities that started just seven weeks before the events began.

"We were able to locate the wells exactly, within a few hundred meters. No matter how you slice it, those events were within a few hundred meters of the wells," Frohlich said.

More than 200 disposal wells were active in the Barnett Shale area, however, and the authors questioned why there were only one or two areas of felt seismicity.

At this stage of research, scientists are still searching for answers about seismic activity triggers and the relationship between existing geology and induced events.

"In the case of the DFW location, there was a minor fault near the earthquakes. That might have had an effect," Frohlich commented.

He said the study did serve to eliminate the likelihood of induced seismicity related to other concurrent oil and gas operations in the Barnett Shale.

"Our study has found only earthquakes associated with disposal wells. It isn't the drilling. It isn't the hydrofracturing. It isn't the production," he observed.

Frohlich doesn't rule out the possibility of induced events occurring from other activities, including oil and gas activity. Monitoring coverage is limited in Texas, a large state with many lightly populated areas.

"An earthquake of 3.0 or 3.5 magnitude could happen in Texas and we might not know," he said.

That induced seismicity can and does occur isn't in question, Frohlich noted.

"Some people say, 'It's impossible that we'd be causing an earthquake.' And those people are obviously unaware of the Denver earthquakes and all the other examples," he said.

Researchers are hoping for more tools, more monitoring, more data to study, more understanding of how existing faults and their type and orientation fit into the induced seismicity picture.

"It's in the interest of everyone," Frohlich said, "whether you are a producer, a citizen or a scientist, to keep doing the research."

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announced buyout of XTO with its impressive portfolio of domestic shale gas, tight gas, coalbed methane and shale oil.

International interest in owning a piece of the action while acquiring the technology needed to develop shale plays overseas is obvious when considering the deals being cut between domestic shale players extraordinaire, e.g. Chesapeake, and other countries as well as sovereign wealth funds.

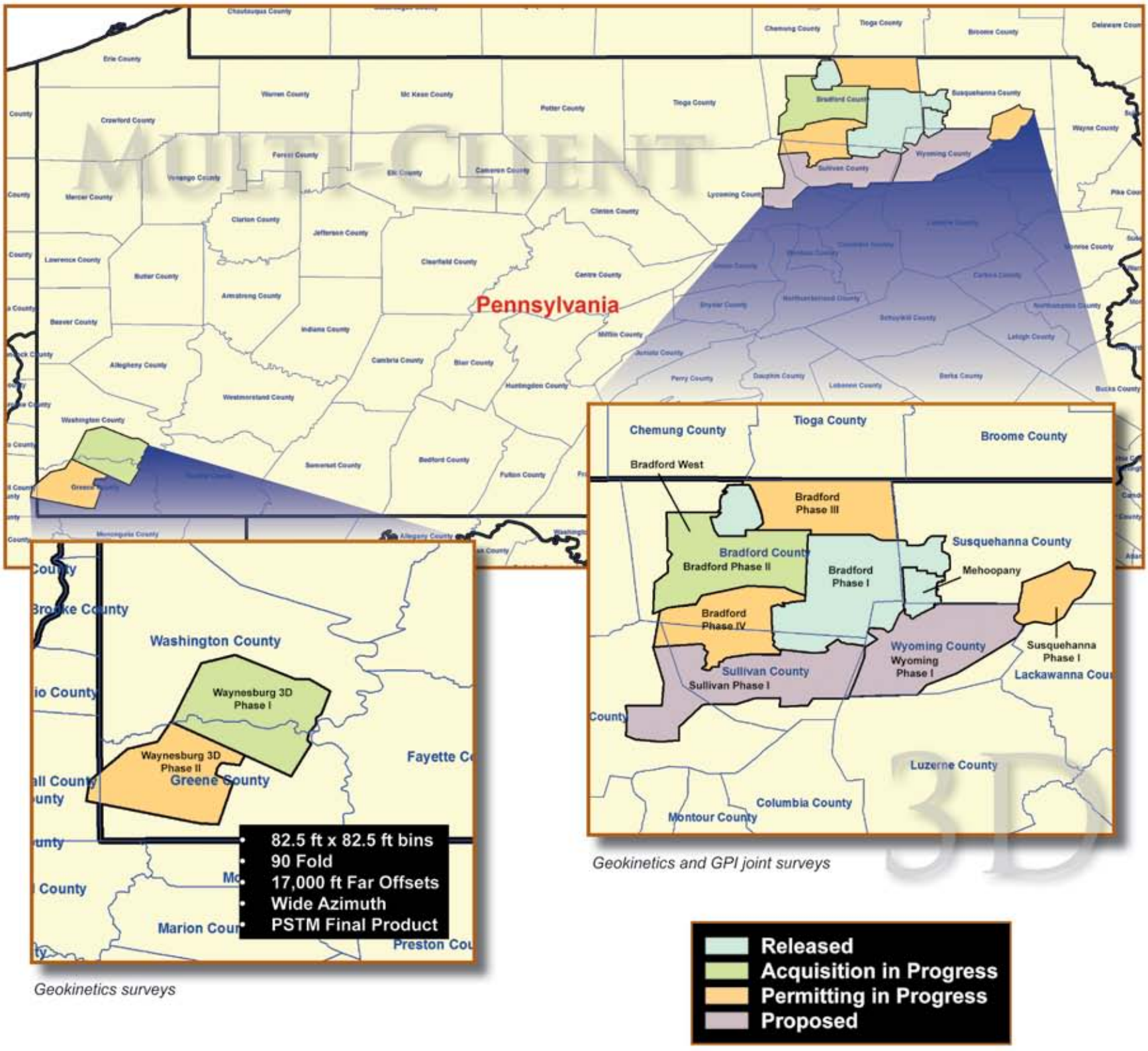
In the seismic arena, Trammel said 4-D applications are becoming common in shale plays. Sensors placed down the wellbore serve various purposes, such as tracking the success of hydraulic fractures over time.

Three-dimensional seismic is used for infill drilling all over the country, and Trammel emphasized that 3-D can potentially work wonders in abandoned fields, citing central Kansas as a good example.

"With the industry chasing liquids so heavily, they're using 3-D to find by-passed hydrocarbons around some of these old abandoned oil fields there," he said. "It's a wonderful example and could have far reaching effects.

"When you consider the potential for enhanced oil recovery," Trammel said, "one of the things we've studied is if we could increase oil recovery by only about 10 percent globally – which is very achievable – we will produce more oil than throughout history."

You Need a Better Image of the Marcellus Shale!



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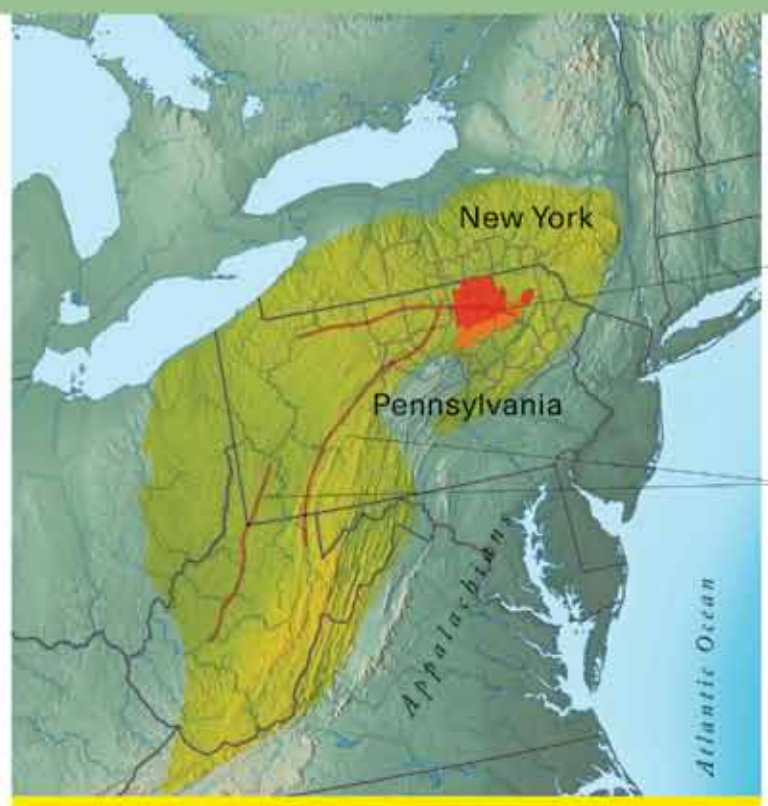

MARCELLUS PLAY

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Our ongoing 3D survey covers 2,100 square miles in this active region.

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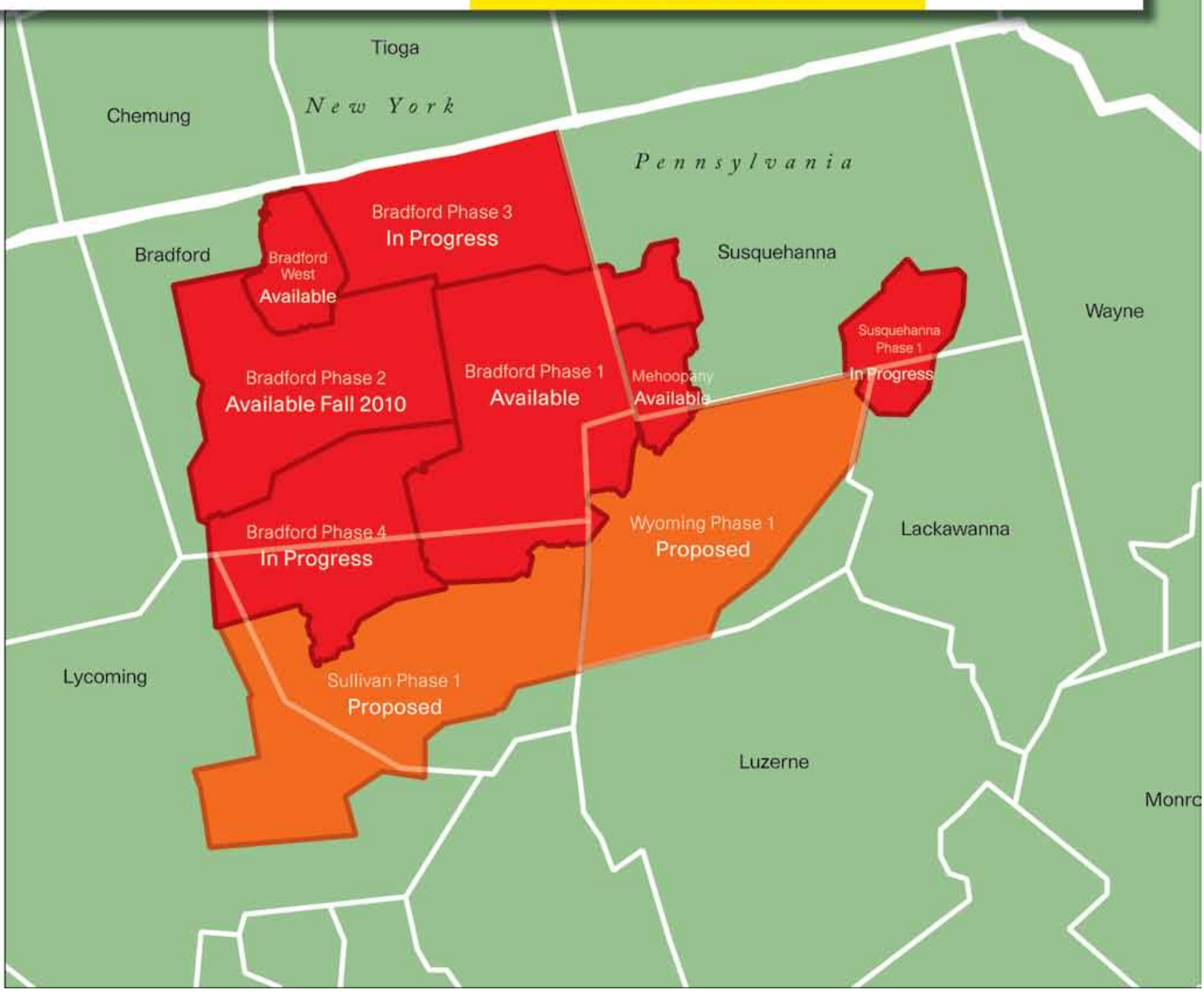

'… a non-cable land world in 10 years or less'

Nodal Seismic's Light Footprint a Big Plus

By LOUISE S. DURHAM, EXPLORER Correspondent

Evidence abounds that industry interest in nodal seismic technology continues to escalate – for both land and marine applications.

There's a wow factor here – even though the concept of autonomous ocean bottom seismograph data acquisition is somewhat old hat.

It originated decades ago in both academic and government circles, prompted by their interest in deep crustal studies and nuclear test monitoring, respectively.

Many years later, in the late 1990s, SeaBird Geophysical developed the first commercial autonomous OBN (Ocean Bottom Node) system.

FairfieldNodal has played a high-profile role in the commercial development of autonomous OBN seismic technology, following years of experience manufacturing and applying systems that initially were nodal only in concept.

Today, its efficient yet complex no-cable nodal systems are quite straightforward in application.

The autonomous battery-powered nodes are deployed on the seabed or dry land, where they record data continuously for pre-determined lengths of time before being retrieved to download and QC the acquired data prior to redeployment.

With no cables to contend with and the flexible deployment capability of the autonomous nodes – even in the marine environment, via remotely operated vehicles

Photos courtesy of FairfieldNodal

Getting ready for nodal seismic operations aboard the Carolyn Chouest ROV/node vessel for the Shell survey in the Mars area of the Gulf of Mexico.

– the nodal seismic systems are designed to meet a number of needs, according to Keith Matthews, sales director, systems division at FairfieldNodal:

- More flexible acquisition geometries, e.g., wide and full azimuth for land surveys.
- Reduced downtime and maintenance.
- Improved depth imaging.
- Increased productivity.
- Insignificant footprint.

"I think we're headed for a non-cable land world in 10 years or less," Matthews predicted. "I expect a big chunk of the industry to switch to nodal systems without cables in that time frame."

Water Works

Thus far, marine nodal seismic surveys have been implemented in the Gulf of Mexico, West Africa, North Sea and the Middle East.

"From my personal reading of the tea leaves, I see interest in nodal technology picking up, with four early adopter majors – Total, Chevron, BP and Shell – obviously having an interest in it and leading the way," said Bob Rosenbladt, Shell's geophysical operations team leader-Americas.

Autonomous nodal seismic acquisition attracted considerable industry attention in 2005 when FairfieldNodal's no-cable Z3000® marine deepwater system was first used for commercial application at the BP-operated Atlantis Field in the deepwater GOM.

Shell hopped onto the commercial nodal bandwagon in 2007, deploying the same deepwater system at its Deimos Field in about 1,000 meters of water in the GOM. The successful 3-D program included a small scale 2-D node repeatability study, aptly demonstrating that OBN data acquired with autonomous nodes exhibit repeatability, making them ideal for 4-D implementation.

"The uptick in the data quality was greater than originally expected," Rosenbladt said. "We were thinking about the long offset and wide azimuth helping with illumination issues subsalt, and it turned out noise suppression characteristics were better than expected."

Shell also used the deepwater system to conduct a seismic survey in the Mars area in the GOM and now has the crew working elsewhere. The core part of the Mars area program was a 4-D monitor survey that extends over a larger area than the original survey.

"Because you can replace those nodes back very accurately, it works nicely for 4-D applications as compared to streamer applications," Rosenbladt noted.

"We're seeing in many areas that nodal is cost effective and highly desirable, and

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what we're seeing looking down the road is if you can drive costs down, there will be even more areas of application," he said. "The more you get the costs down, the more fields where it will be economic."

OBN costs have proven to be acceptable at the development or appraisal scale in most instances, and they also can be crucial assists in exploration surveys, e.g., where a platform sits in the middle of a survey area restricting access.

But when it comes to competing with the costs of large-scale streamer WAZ surveys over, say, 200 OCS blocks, nodal technology is not there – yet.

"It will take a step change to compete with streamer on something like that," Rosenbladt said. "But it's still an evolving technology, and we're all learning.

"It's a big aspiration to see nodes used for large exploration areas, and we'd like to see if that can be made to happen," he said. "That's what we call a stretch goal."

Something For Everyone?

If you're fretting that nodal seismic data acquisition might be beyond your reach, it ain't necessarily so.

"The big boys get to play first," Matthews noted. "But we already see an increase in the number of smaller companies starting to see the benefit of using nodes."

This is especially true on land, where the use of no-cable nodes in particular means absolutely no troubleshooting. This translates into faster shooting and higher productivity, resulting in lower overall cost and the potential for fewer HSE incidents.

A number of nodal land systems are available to industry. Bearing designations that include no-cable, cable-free and cableless, these systems include FairfieldNodal ZLand® system, ION FireFly®, Sercel UNITE, Ascend Geo Ultra, and OYO GSR.

Unobtrusive nodes are particularly suited for congested, environmentally sensitive urban environments.

An example is the recently completed successful 2-D survey in the midst of the Long Beach and Signal Hill municipalities in California. Signal Hill Petroleum employed the no-cable ZLand® system there, using buried nodes to record over a part of the giant Long Beach/Signal Hill oil field, where it is the principal operator. (See October 2009 Explorer.)

Both civic officials and residents expressed approval at the conclusion of the project.

Survey operator SISCO then moved on to acquire both a 4-D and a surface micro-seismic survey for another client in a different geographic area. An identical system was used to acquire the high resolution, closely spaced data near two wells that were being perfed and fraced.

Look for land nodal seismic systems to be in higher demand as the BLM tightens access to certain locales – particularly in the Rocky Mountain region, where the agency controls considerable acreage attractive to the industry.

"The BLM just issued new restrictions for archaeological areas, where they really don't want crews on the ground at all," Matthews said. "It's getting tougher to get permits for seismic crews because of these sites, and a lot of crews have professional watch crews to be sure they don't disturb archaeological sites.

"The land permitting challenge is in addition to complying with restrictions such as mating season for grouse, worm reproduction and other such issues," Matthews added.

"It's easier to get permits with minimal impact no-cable nodal systems rather than using external geophone strings, cables and such as these things pile up, increasing the chance for damage," he noted. "A no-cable nodal seismic system is very low impact as you only make two passes because of the way of deploying and retrieving nodes."

'Smaller, Lighter, Cheaper …'

If you think urban environments and issues such as ancient remains, wildlife hanky-panky, etc., discourage the use of cable acquisition systems, consider the jungle.

Imagine carrying copious amounts of heavy cables and equipment into these areas of dense vegetation.

Surveys using lightweight nodal systems comprised of fewer pieces of equipment require fewer crewmembers traipsing in and out of these sensitive locales. This results in far less environmental impact.

Vegetative cutting and clearing are minimalized, along with the number of fly camps and potential helicopter support flights, according to comments made by BP during a fairly recent presentation at the Indonesian Petroleum Association annual confab.

The company noted that added benefits are expected from autonomous nodes based on the simplicity and flexibility of the system.

For instance, internal timing and positioning via GPS means obstructions are much simpler to address, without sacrificing subsurface sampling and redundancy.

Steve Mitchell, vice president, systems division manager at FairfieldNodal summarized the principle issues that must be addressed in order for nodal systems to meet the coming demands and needs of industry.

"The next generation node must be smaller, lighter, cheaper, more plentiful and longer lived," Mitchell said.

"Much of the mass of the OBN unit is in the batteries," he noted. "Reducing power requirements is key to extending deployment longevity and reducing size and unit cost.

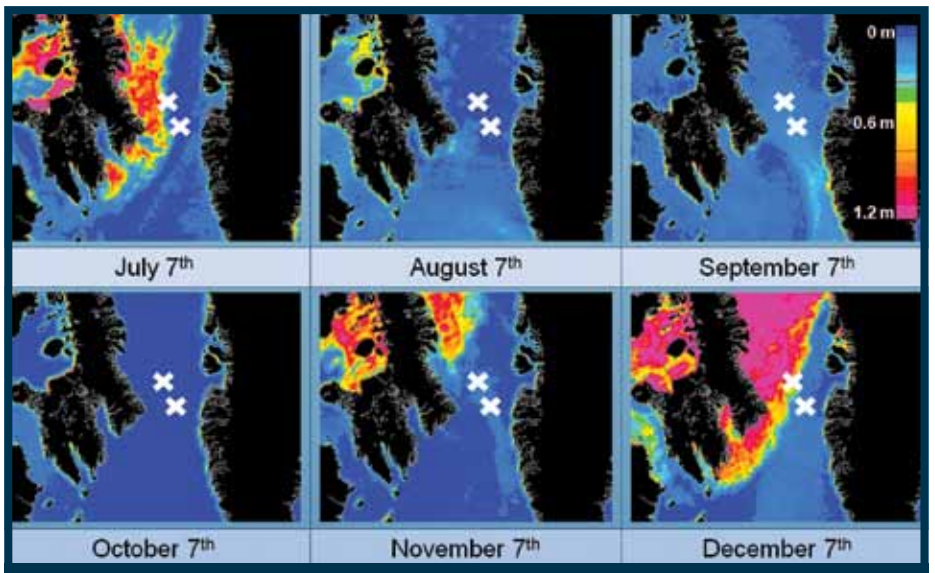
"Smaller, cheaper and longer-lived nodes will make larger 2C surveys or denser 4C surveys cost effective.

"In the deep water, ROV operations represent a significant portion of overall cost structure," Mitchell noted. "Innovative deployment and retrieval methods that reduce this cost could facilitate the expansion of OBN technology into more markets." E

Per Eivind Dhelie presented the paper "Successful 3-D Seismic Exploration Offshore West Greenland Using Dual-Sensor Streamer Technology" at the recent AAPG International Conference and Exhibition in Calgary, Canada.

Photos, graphic courtesy of PGS

Working on the back deck in Arctic conditions can be cold and tough – but crews were well prepared with modern seismic equipment designed to withstand the wear and tear. Technical downtime was limited to only a few hours for the whole three-month arctic campaign.



Sea ice distribution for the six-month period July to December 2009; the white Xs mark the survey areas. The survey ended November 6 – just in time before the sea-ice moved in again.

'Stoplights' managed infill plan

Greenland Gets 3-D Look

BY LOUISE S. DURHAM, EXPLORER Correspondent

When it comes to hydrocarbon exploration, challenges are a given.

And when it comes to a list of daunting regions for exploration, the Arctic ranks about as high on the list as anything in the world.

But the potential for possible big finds in certain locales, e.g., offshore West Greenland, is a powerful incentive for the companies to figure out whatever it will take to keep the exploration process moving along.

West Greenland has a sketchy history of exploration. Two-dimensional seismic data were acquired as far back as the 1970s and as recently as 2008. Several wells have been drilled thus far.

(At press time, Greenland's offshore potential was underlined when Cairn Energy announced it had tested pockets of oil and evidence of gas in the Baffin Bay Basin.)

Even so, a commercial discovery has long remained elusive.

"The potential for hydrocarbon discovery remains high," said Per Eivind Dhelie, chief geophysicist at PGS.

"Upper Cretaceous sedimentary sections outcropping along the coast of the nearby Nuussuaq Peninsula reveal excellent quality reservoir, source and seal rocks overlain by Paleocene age volcanics," he said. "These offer excellent analogs to sections potentially buried deep beneath the ocean floor.

"Additional positive hydrocarbon indicators include numerous oil seeps discovered along the coast in the Disko-Nuussuaq-Svartnhuk Halvo region," Dhelie said. "These have been typed by the Geological Survey of Denmark and Greenland to five different source intervals dating from Cretaceous to Paleogene.

"Four-way structural closures have been mapped based on vintage seismic data in the West Disko area, despite sub-basalt data quality issues," he added. "And interpreted gas clouds along with amplitude anomalies, some with favorable AVO signatures, can be observed in the shallower Tertiary section, hinting at potential deeper hydrocarbon charges."

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"This is a downright unfriendly area for seismic data acquisition" – but also a bit beautiful. Fantastic icebergs were both dangerous and compelling.

Greenland

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Unfriendly Regions

To the chagrin of the interested companies, this is a downright unfriendly area for seismic data acquisition.

As PGS geared up to acquire two 3-D seismic surveys for Husky Oil Ltd. in the Arctic waters offshore West Greenland in 2009, the company approached the task with eyes wide open.

Dhelie, outlined some of the formidable challenges to seismic exploration there, including:

- Short three-four month ice-free season.
- Avoiding icebergs during acquisition.
- Hard water-bottom notorious for strong multiple energy.
- Volcanic flows with associated dikes and sills within and overlying prospect objectives.

It was determined that PGS's dual-sensor 3-D GeoStreamer technology with deep-tow capabilities was the method-of-choice to overcome the data acquisition hindrances indigenous to the area – namely the weather and the seismic imaging challenges. The more than 2,200-square-kilometer 3-D surveys took place in West Disko Blocks 5 and 7, which are operated by Husky.

Dhelie noted that dual-sensor streamer technology allows for streamers to be towed at greater depths –15 meters for this project – than conventional (hydrophone-only) seismic cables without compromising the high frequency spectrum. With all six seismic streamers at tow depth of 15 meters, surface noise is minimized and the operational window can be increased, allowing acquisition to proceed in inclement weather conditions.

Over the course of the Arctic program, downtime for weather was 3 percent and 12 percent for Blocks 7 and 5, respectively, which was significantly lower than expectations if streamers were towed at a more conventional depth.

"The deep-towed streamers also enhance the natural frequency response below 20 hertz, which is important for sub-basalt imaging," Dhelie said. "We used the 2-D vintage data from the area to analyze and optimize acquisition parameters, and special attention was focused on source optimization for increased low frequency penetration.

"The increased energy recorded in the amplitude spectrum lower than 20 hertz was found more appropriate to penetrate primary energy through attenuative volcanic rocks than what conventional tow depths have achieved historically," he noted.

Warning: Iceberg Crossing

Even though the survey was implemented during the area's annual ice-free period, weather conditions were far from summer-like.

"The water temperature was below zero," Dhelie said, "so when you take things out of it they freeze instantly, which we knew in advance.

"In the water, these things are moving around, so they don't freeze," he said. "Also, this is salt water, which helps prevent freezing."

Special consideration in program operations included radar imaging for iceberg detection to avoid striking the icebergs, given that the survey spread made it impossible to turn quickly to avoid obstacles.

Because the survey had to be accomplished during the brief ice-free season and the icebergs likely would obstruct sail lines, project success required efficient infill management.

Dhelie noted that a proprietary infill method commonly referred to as the "stop-light system" proved to be invaluable. Stop-light plots were constructed and reviewed online by Husky and PGS to determine the need for extra infill lines.

Survey operations boasted no negative incidents.

"There were thumbs up everywhere," Dhelie said.

"The dual-sensor technology proved invaluable to the survey efficiency as well as to the very good data quality," he emphasized.

The project was the first 3-D survey in this locale where other companies also hold blocks. If a successful well should come in, it most likely would open up a whole new area to exploration, Dhelie suggested. ■

Fred Kierulf presented the paper "Arctic 3-D Seismic Across the Transition Zone From the Beaufort Sea Onto the Mackenzie Delta, Northwest Territories, Canada," at the recent AAPG International Conference and Exhibition in Calgary, Canada.

GEOPHYSICAL REVIEW

Mackenzie Delta Effort Yields Gas Well

Not Much is Easy For Arctic TZ Shoot

By LOUISE S. DURHAM, EXPLORER Correspondent

Often the mere mention of transition zone (TZ) 3-D seismic surveys brings to mind oppressive heat, mosquito swarms and other unpleasant thoughts.

After all, many of these surveys occur along coastal zones in various parts of the world where heat, humidity and predatory critters can make life miserable for seismic crews much of the year.

But is this worse than the challenge posed by acquiring data in a frozen TZ?

It's likely a toss-up.

There was ice aplenty for MGM Energy's TZ 3-D program conducted during the winter of 2007-08 in the Canada's Mackenzie Delta region, Northwest Territories, including portions of the Ellice and Langley islands, Mackenzie River channels and the shallow Beaufort Sea.

The 144-square-kilometer survey, dubbed the North Ellice 3-D, was located on the northwest edge of the Mackenzie Delta, with the TZ between onshore and offshore frozen during acquisition.

The data were acquired during a 111-day stretch beginning Dec. 10, 2007. Field operations kicked off the previous September in order to pre-position the equipment and camp prior to freeze-up of the Mackenzie River.

Over the course of the survey, about 65 percent of the source points were dynamite shotholes drilled through floating sea ice, according to Fred Kierulf, geophysicist at MGM.

Vibroseis was used on land.

Once a survey is completed in this part of the world, operators submit a report to the government describing the work accomplished and how it was done. In other words, the parameters of past surveys are all in the public domain.

"This is not high tech, but it's a tough environment, so we have to use proven technology," Kierulf said. "It's an area where technology continues to develop based on everyone's input.

"We read about all that had been done and used all the hard work that had already been done in the Delta," he noted. "There are about a hundred past surveys we read through to see what the guys did and problems that were encountered."

He likened it to heading out to wild, wooly parts of the world, reading journals of those who went before.

There are only a couple of seismic operators in this area, and they bring all their skills to this challenging part of the world.

"Everyone uses the same group of guys who know the equipment that works there as there are not a lot of options," Kierulf noted. "It's not state-of-the-art, but it's close."

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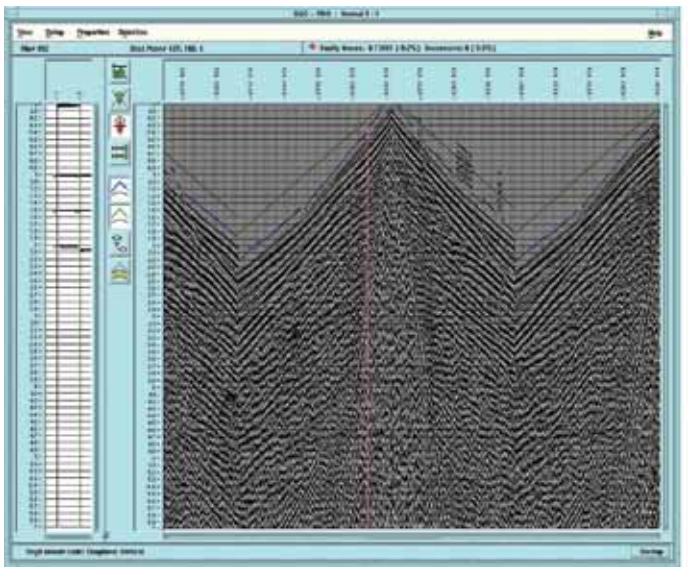
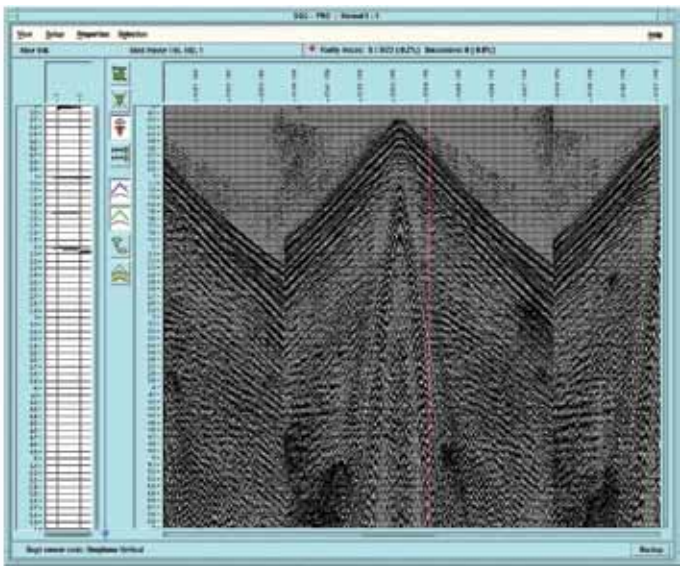
Photos, data courtesy of MGM Energy Corp.

Scenes from the 3-D seismic survey on the northwest edge of the Mackenzie Delta's transition zone – a 144-square-kilometer project that required 4,505 dynamite source points (on ice) and 2,125 Vibroseis source points (on land). Top: A view of camp before the big freeze up. Bottom: Action after the freeze arrived.





Dynamite source below floating sea ice showing ice cracking noise bursts.

Arctic

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A Short Window

The end product is good quality seismic data, but the effort required to get there appears to be almost archaic in these times when business – owing to all the high tech electronic communications gadgets and gizmos – sometimes is accomplished essentially in an instant.

"Getting the information organized and down from north of the Arctic Circle to the computers that can process it takes a long time," Kierulf said. "We were shooting in February and March and had to decide before the middle of summer where to drill the wells the next year."

He emphasized there are only a few winter months to acquire seismic and to drill wells. Not only do sensitive species use both land and marine portions of the area in the summer, but drilling crews need to exit the ice before it begins melting.

"There's time pressure to get it all done and to get the tapes and such down from there on a weekly flight," he emphasized. "The processing had to be done quickly, and this is harder to do when there are long distances involved and you don't have the Internet.

"We were essentially trying to do real time processing even though we had to wait for the tapes to come down almost by dog sled," Kierulf commented humorously.

He explained that Internet access of a sort actually was available, emphasizing that the connection shared by 150 people was like a dial-up, which was not conducive to sending shot records.

In fact, everyone there was completely out of touch with the world for days at a time during big storms.

'Ugly Seismic'

In its raw state, Kierulf said the acquired data doesn't look like seismic from anywhere else. Not surprisingly, there were significantly different seismic responses recorded on the ice compared to data collected over the islands.

"It's ugly seismic with strange noises," he noted, "and you can't just run it through standard computer processing. You must spend a lot of time to make it look good yet rather quickly."

The seismic data processing was contracted to WesternGeco, and Kierulf had high praise for the processing folks, emphasizing that they did a great job.

MGM has drilled two wells based on the processed seismic, but they failed to encounter significant hydrocarbons. A third well went down based on earlier seismic data; it was a gas discovery.

There have been commercial discoveries in the region, but they await development seeing as how the product can't be sold because construction of the Mackenzie Gas Project Pipeline has been delayed repeatedly, according to Kierulf.

He noted that a consortium of the majors is going through regulatory and environmental reviews to build a pipeline.

Meanwhile, MGM intends to go back later to drill, as they believe there are other opportunities based on the 3-D seismic just acquired – but absent the pipeline, there's no rush.

As Kierulf said: "We'll wait until there's a better economic reason to do it."

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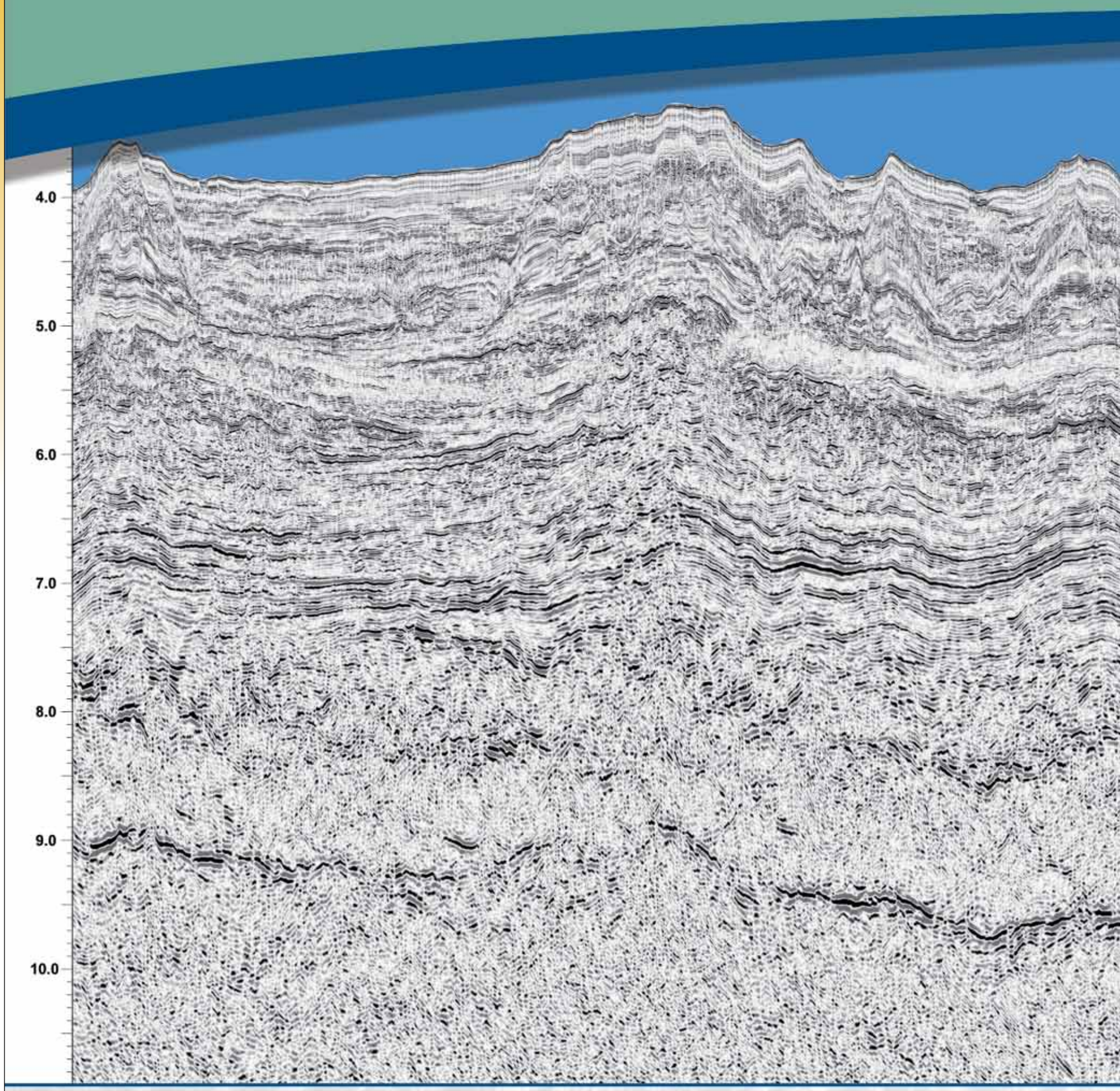
At ION, big ideas turn into real results for our clients. Global E&P operators regularly come to us with incredibly complex imaging and operational challenges. We work with them to deliver groundbreaking solutions that unlock reserves and increase production. For example, we developed a full-wave seismic solution for two Chinese E&P companies to better characterize their conventional and unconventional reservoirs. The approach included innovative acquisition systems that efficiently recorded full-wave data in a variety of challenging operating environments. Our insights helped to optimize well placements and increased the success rate of one client's drilling program from 35% to 85%. Stories like these abound at ION. Find out what real collaboration feels like. iongeo.com/collaboration

ion

Offshore Liberia Ultra Deep

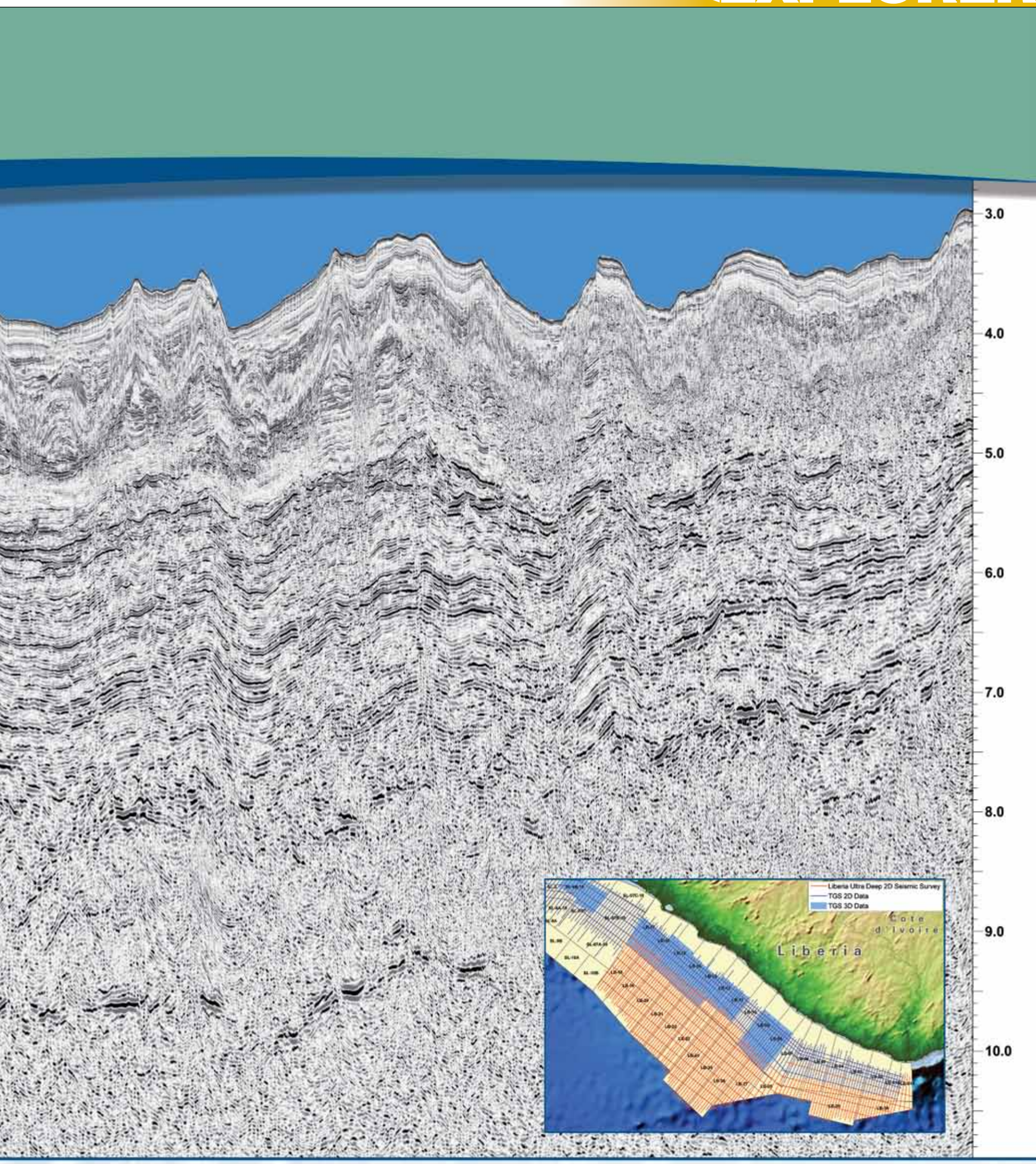


Geophysical Products

Geological Products

Imaging Services

TSG has an extensive library of 2D and 3D multi-client data offshore Liberia. The most recent program, Liberia Ultra Deep, includes long offset seismic, gravity and magnetic data. It extends the existing 2D data out to water depths of 4000m. This program will be utilized for the planned 2011 license round.



Scott Stockton presented the paper "The Use of 3-Component Seismic Data to Identify Sweet Spots in Fractured Bakken Reservoirs" at the recent AAPG International Conference and Exhibition in Calgary, Canada.

Bakken fractures yield the goods

Oil Shale Takes Turn in Spotlight

By LOUISE S. DURHAM, EXPLORER Correspondent

Shale gas is in.
Shale gas is out
Shale oil is in.

No one would argue that the direction of this industry can change on a dime – and fortunately, most players have learned that you just gotta go with the flow.

Following the all-out drilling charge to punch down as many wellbores as possible – often to hold onto leases – in the still-relatively-new shale gas plays across the United States, there now is a massive inventory of clean-burning natural gas.


STOCKTON

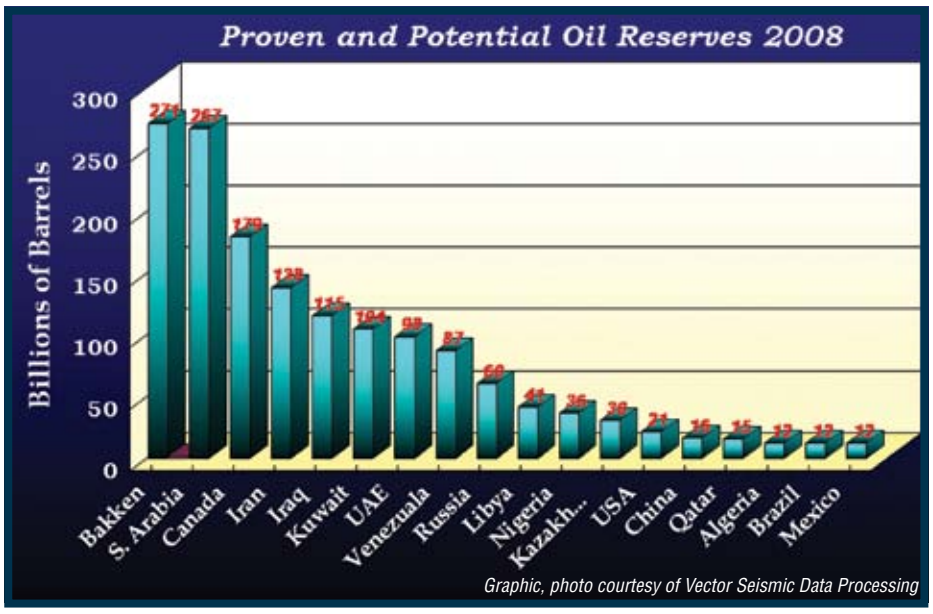
In fact, you might be tempted to make a buck or two by scouting for new facilities to store the burgeoning supply.

Best to cool your heels.

With all this new natural gas supply and $4/Mcf – give or take – looking tops for now, there's talk of laying down some rigs. It's not about resting on laurels and taking time off to chill, but to head for the other new best thing, i.e. oil shales and/or gas shales rich with liquids, such as the Eagle Ford in South Texas.

It's a matter of simple math: oil continues to fetch a price generally in the upper $70/bbl range.

The Big Dude shale in the oil game is the Bakken shale oil play in Montana and North Dakota, which is becoming increasingly popular following a period of successful yet relatively low profile action.



Graphic, photo courtesy of Vector Seismic Data Processing

Adding to the allure of this play is the U.S. Geological Survey assessment that revealed the Bakken harbors about 3.65 billion barrels of undiscovered technically recoverable oil along with 1.85 Tcf of associated/dissolved natural gas and 148 mbo of natural gas liquids.

The widespread Upper Devonian-Lower Mississippian Bakken formation is comprised of an upper and lower shale member and a mixed siliciclastic carbonate middle member, which is ordinarily referred to as a dolomitic sand or sandy dolomite.

This middle section is the target of the drill bits that ordinarily go down about 10,000 feet vertically before veering horizontally into the brittle dolomite, where multi-stage fracing is used to more efficiently produce the oil.

Not all wells are created equal.

"When you spend maybe $7 million on a horizontal well and bring it in at 200 to 300 barrels a day, that's economic failure," said AAPG member Scott Stockton, executive vice president of Vector Seismic Data Processing in Denver. "You need at least 1,000 barrels a day to be able to smile when you leave the wellhead."

Oh, So Sweet

Enter multi-component seismic data to help ID the sweet spots.

In early 2009, Vector Seismic formed a consortium to evaluate the seismic signature of fractured reservoirs in the Middle Bakken. This ultimately led the company to determine that differences in the seismic image of shear waves over producing wells vs. dry holes in the Bakken formation are key for drilling success.

The Middle Bakken has proved elusive when it comes to detailed imaging from conventional surface seismic applications, for two reasons:

- With a thickness typically between 15 and 60 feet at a depth of 8,000 or so, it's below resolution of conventional seismic methods.
- The P-wave response of seismic energy in the fractured vs. non-fractured rock is virtually identical.

Stockton noted that companies have acquired significant amounts of conventional seismic data in the play and are getting a great structural picture – but

See **Bakken**, page 36

The 3-component geophones used to record the Vector Bakken 2-D/3C test line are true geophones. Each phone was buried in a pre-drilled pilot hole.

Bakken
from page 34

they haven't been able to ID the fractures, which are required for reservoir to exist in the tight siltstone having little or no native porosity or permeability.

"We took a high resolution approach, going in very broadband," Stockton said. "This does image the thin beds and small faults that are potentially indicative of the presence of fractures, but it doesn't get you all the way home."

They decided to use converted-wave recording, given there's only one working set of shear wave vibrators available in the continental United States, according to Stockton. He noted these were unavailable at the last minute.

"In retrospect, I was glad," he said. "If you do a converted wave (3-C) seismic survey, it means you have available to you all kinds of P-wave sources, such as dynamite and Vibroseis. If you can get as good an image with vibrators, you can save a lot of money.

"We recorded a high resolution line twice over the area of interest, once with vibrators and once with dynamite," he noted.

A high resolution converted wave seismic profile tied the dry-hole Behm Energy well in Mountrail County in northwestern North Dakota with Bakken producing wells to the west in Parshall and Sanish fields. The seismic signature of the waveform on the converted-wave image shows marked differences that can be correlated to natural fractures in the Bakken formation and better production.

Hot and Haute

The MO in the Bakken play thus far has been to chase after tectonic fractures. Even though deep underground, e.g. 8,500 to 12,000 feet, they tend to "pop" on the surface showing up pretty much as straight lines, or lineaments.

The other fracture mechanism is hydraulic, which Stockton thinks is key to really prolific wells in the Middle Bakken.

It's all about the Bakken petroleum system, which is a closed, self-sourced system.

The combo of a uniquely closed petroleum system, a high thermal gradient and volumetric expansion of the Upper and Lower Bakken kerogen into oil has resulted in high potential for creating in situ fractures parallel to bedding planes.

"When kerogen cooks out of the Bakken shale it experiences an intense volumetric increase of about 114 to 170 percent," Stockton said. "There's great energy stored in that volume increase and it wants to fracture the rock, mainly along bedding planes."

He noted that the horizontal fractures can be a huge factor in terms of where the reservoir is and where it's best.

"Where the tectonic fractures intersect the hydraulic, you get the best wells," he emphasized. "You get great wells where you have both, good wells where you have hydraulic fractures, okay to good wells where you have vertical (tectonic) fractures."

It's all mighty hot and haute.

But the oil won't do anyone any good if it just sits on site in tanks.

"The current interest in the Bakken might be called a frenzy," Stockton exclaimed. "Now that we've shown that seismic can tell where the oil is, the big problem is the infrastructure – like, how do you get oil out to the market?"

In the advanced technology milieu of shale drilling and production, the current transport solution is so low-tech one is tempted to laugh.

But, hey, it works.

Plus, it's a fine example of good old oil patch can-do.

Scott noted some of the companies bought a bunch of old rail lines and rail cars and basically have tanker trains that they load up with oil to transport to Oklahoma and elsewhere for refining.

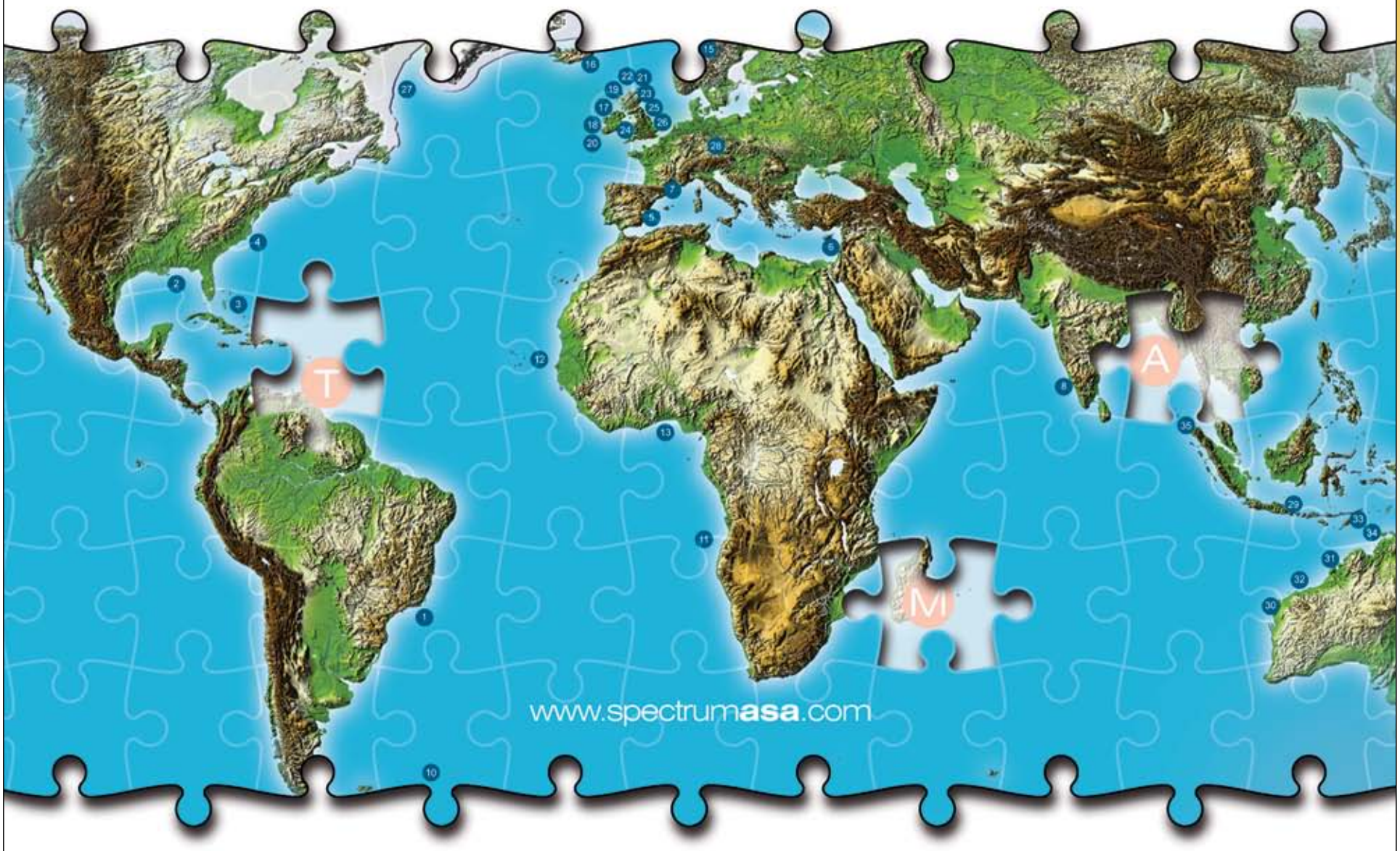
"This is American ingenuity at its best," he exclaimed. "It was one heckuva idea.

"This is a massive transportation issue," he said, "and there are a lot of abandoned rail lines up there in North Dakota."

Given the potential for so much more production in this play, perhaps some enterprising investors will figure out a way to go long on old rail cars.

Andaman, Madagascar, Trinidad

Exciting **NEW** frontier Multi-Client projects for 2010



Let Spectrum solve your exploration puzzle

Trinidad & Tobago:

Spectrum, in conjunction with the Ministry of Energy and Energy Industries, are reprocessing the Trinidad and Tobago Deep Atlantic Area Survey acquired in 2002.

The 12,472 km project will be processed with state-of-the-art processing techniques and will be available in mid 2010.

Madagascar:

Spectrum has signed an agreement with OMNIS (Office des Mines Nationales et des Industries Stratégiques), to reprocess various seismic surveys offshore West, South and East coasts of Madagascar.

The surveys have a total length of approximately 6,000 line km and will be available mid 2010.

The Andaman Islands:

Follows the highly successful reprocessing of West Coast India data and forms part of Spectrum's continuing commitment to the promotion of exploration in the Indian sub-continent.

Spectrum is now reprocessing 10,588 km of 2D seismic data offshore of the Andaman Islands in the Indian Ocean.

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Rare gas selling for $500 per liter

Lack of Helium-3 Sounding Alarms

By DAVID BROWN, EXPLORER Correspondent

A crucial shortage in the world's supply of helium-3 could alter the use of an important tool for the oil and gas industry.

And that's just one problem. The rare helium isotope also is used in applications ranging from cryogenic studies to lung imaging in medicine.

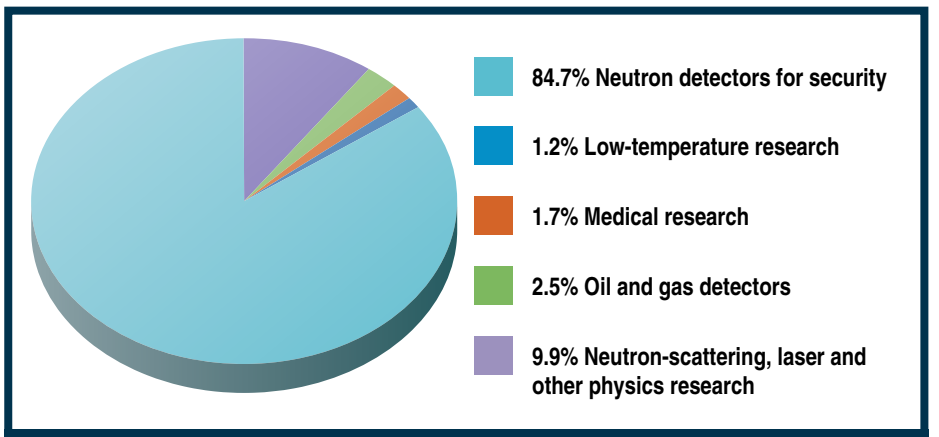
Far and away the largest consumer of helium-3 in the United States recently has been the Department of Homeland Security, which uses it in radiation sensors. Think of trying to stop someone who's smuggling a small amount of plutonium for a nuclear weapon.

"Crisis really is the best word for this situation," said AAPG member Bo Sears, vice president of Inter-American Corp. in Dallas, one of the industry's small number of helium explorers.

For oil and gas companies, helium-3 is an essential component in neutron logging tools used worldwide.

"Helium-3 is used in neutron detectors for neutron porosity tools, which are one of the key instruments used to locate hydrocarbons, estimate petroleum reserves and make production decisions," said Brad Roscoe, scientific advise and nuclear program manager at Schlumberger-Doll Research in Cambridge, Mass.

"The neutron device is particularly used to establish the rock and fluid parameters which help determine these properties," he added.



Rough breakdown of helium-3 use over the past five years. The largest use, by far, is for neutron detectors for security screening by the departments of Homeland Security, Defense and Energy.

Downhole neutron tools measure the amount of hydrogen in rock pores as an indication of porosity.

"Since the neutron porosity measurement is a key measurement," Roscoe said, "it is run in almost every oil and gas well in the world."

A Costly Shortage

How bad is the shortage?

The U.S. Department of Energy reportedly has less than a one-year supply. Russia, another helium-3 seller, has essentially stopped exporting it.

While natural gas recently sold for under $4 per thousand cubic feet at the wellhead, and the U.S. Bureau of Land Management raised helium gas prices to $75 per thousand cubic feet, helium-3 now typically sells for at least $500 per liter.

"Two years ago it was $85 a liter. Government agencies didn't know the U.S. was running out of helium-3 until 2008," Sears said.

At least one reported helium-3 purchase was for more than $2,000 per liter.

When the severity of the shortage became apparent earlier this year, alarms went off throughout the scientific community, especially among those researchers who had no substitute for helium-3.

The same concern has spread to companies that need helium-3 for commercial applications.

Supplies of the common form of helium found on Earth, helium-4, also are shrinking. That's an ironic reality, since helium itself is the second most common element in the solar system.

Helium-3 also is fairly abundant, scattered among the planets, in the soil of the Moon, in the Earth's mantle. But even though it's present in the Earth, it is increasingly scarce on the Earth.

Inter-American explores for natural gas that contains a significant amount of recoverable helium, Sears said. He acknowledged that helium exploration is a tiny part of the overall industry.

"We're a traditional oil and gas company but we've begun focusing on helium exploration. In our case it makes more sense to go after the high helium-4 reserves," he noted.

Even when helium is found with natural gas, the percentage content is usually small.

"Economic helium is anywhere from 0.3 percent up to the highest we've seen, which was 9 percent. That was in the Four Corners area and that supply was exhausted in the 1960s," Sears said.

"Ideally," he added, "we'd want a helium composition of at least 1 percent."

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A Critical Need

Project areas for Inter-American include New Mexico, Utah, Colorado and Kansas. Most helium-rich gas in the United States is found in the mid-continent and southwestern states.

Target helium-rich fields indicate an abundance of uranium and/or thorium in basement rock, since their radioactive decay produces helium, and the presence of heavy, deep-seated faulting.

The very small amount of helium-3 found with helium-4 can be separated out – at considerable cost and in limited quantity.

"It's in the parts per million. On average in natural gas deposits it's 0.2 parts per million of the helium-4 content," Sears said.


SEARS

Because of the relative abundance of primordial helium-3 in the mantle, geochemists use the helium-3/helium-4 ratio as a tracer to identify the presence of a mantle component in petroleum systems, he noted.

Sears said Inter-American uses the helium-3 ratio to help define helium-4 potential. Analysis of some gas has found an anomalously high ratio, especially in New Mexico.

Helium-3 extraction plants could be built near helium-rich gas fields, but the estimated cost is in the tens of millions of dollars per plant.

Yet the helium scarcity is so critical that all options are on the table.

"At this point in the helium-3 crisis, every little bit helps," Sears said. "My concern is that the oil and gas industry will be squeezed out entirely. It could have a horrible effect on the industry, because all neutron tools use helium-3."

Thanks in part to nuclear disarmament, the United States once had a substantial supply of helium-3. Tritium (hydrogen-3) used in nuclear weapons was recovered as the warheads were dismantled. Tritium produces helium-3 as it decays.

A declining amount of recovered tritium and a surge in demand in the years following the 9/11 attacks caused the stockpile to dwindle.

Because the half-life of tritium is over 12 years, Sears said "even if dedicated tritium production began today, which is cost prohibitive, it would be years before you get any meaningful amount of helium-3."

A Crucial Asset

The usefulness of helium-3 in well logging tools lies partly in its high absorption cross section, which gives it high neutron detection capability.

"In well logging two measurements traditionally have been used to estimate the porosity of sedimentary formations – one based on gamma rays scattering and the other on neutron scattering," said Darwin Ellis, author of the classic text "Well Logging for Earth Scientists."

Ellis described the use of the logging tools:

"The gamma ray scattering device measures the bulk density of the rock formation from which the porosity (volume fraction of fluid-filled formation) is estimated, usually assuming that the fluid in the porous volume is water or brine with a density close to 1.0 g/cc.

"If the porous volume is saturated with gas or hydrocarbon with a density much less than 1.0 g/cc, the effect on the density is to reduce its value and the consequent interpretation is to over-estimate the porosity of the formation.

"The neutron scattering device exploits the large influence the presence of hydrogen has on the slowing-down of neutrons, so its response is dominated by the hydrogen content, not the density, of the formation which, in clean, shale-free formations, is associated with the pore fluid.

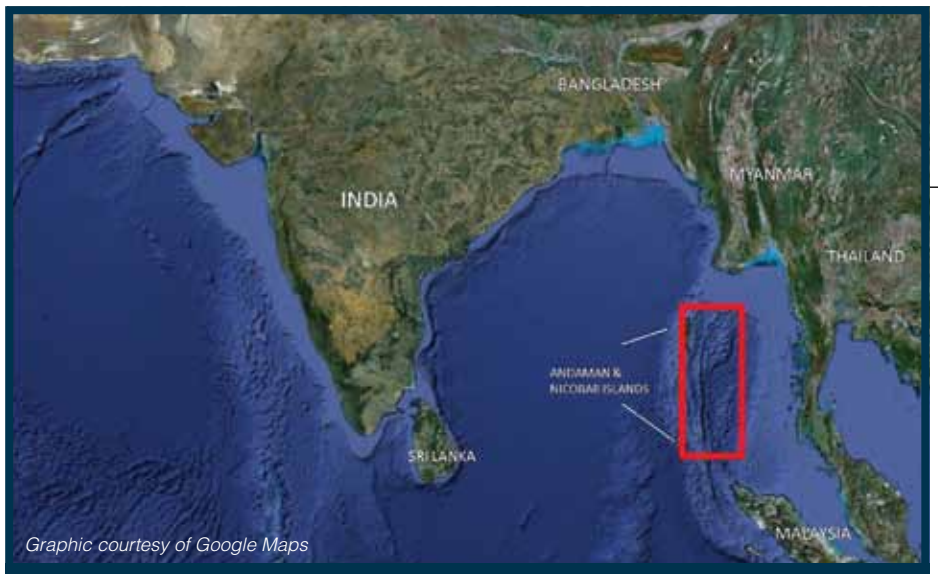
"These devices are calibrated to give an accurate estimate of the formation porosity when the suturing fluid is water. If the formation contains light hydrocarbon or gas, the hydrogen density is less than that of a water-saturated formation and the consequent estimate of porosity from the device will be less than the actual porosity.

"When the measurements from these two devices are displayed together on a log they are transformed so that the porosity estimates overlap when the formation porosity is water-filled – the two traces lie on top of one another.

"If the pore fluid is replaced by a lower density hydrocarbon or gas, the density estimate of porosity will increase and the neutron porosity estimate will decrease – yielding a graphical signature on the log of a possibly very large separation that even a novice interpreter can recognize as a gas zone."

Roscoe said helium-3 also allows the industry to create logging tools that are "small and robust" and capable of withstanding difficult and even tortuous

See **Helium-3**, page 41



Graphic courtesy of Google Maps

The Andaman Islands, located in a basin known for its complex tectonic history, is frontier territory for explorationists – and a recent target for a seismic reprocessing effort.

India Seismic Gets New View

By LOUISE S. DURHAM, EXPLORER Correspondent

When you reprocess a line of seismic data, the second time around can provide a passel of new info.

This was the case when Spectrum ASA reprocessed a 10,600-kilometer line of 2-D multi-client data in the geologically complex area offshore the Andaman Islands off India's east coast.

"The seismic data are from five different surveys ranging from 1982 to 2001 vintage," said Gary Scaife, geological adviser at Spectrum. "The seismic dataset extends over the fore-arc basin, volcanic arc and back-arc basin areas of the Andaman Sea Basin east of the emergent islands.

"The earlier processing was good for the time," Scaife said. "We reprocessed using both industry-wide algorithms and our own in-house algorithms; the project included both pre-stack time and depth migration, or PSTM and PSDM, respectively.

"The main objective of the reprocessing effort was to provide a good quality regional survey," he said, "and to improve the interpretability of the complex structures found within the dataset by improving the imaging of the entire seismic section, both shallow and deep."

SCAIFE

Spectrum was awarded the project via the Directorate General of Hydrocarbons in India.

The Andaman Sea Basin has evolved through a complex tectonic history beginning in the Cretaceous associated with the oblique convergence between the Indian and west Burmese tectonic plates.

Scaife noted the main tectonic elements that can be observed going west to east:

- Andaman Trench/Inner Slope.
- Outer High/Trench slope break.
- Fore-Arc Basin.
- Volcanic Arc.
- Back-Arc Basin.
- Mergui Terrace.

"The Indian sector of the Andaman Sea Basin is regarded as frontier territory, with only 13 wells drilled in the project area east of the Andaman Islands," Scaife said. "The first of these wells hit gas in Miocene limestone."

This discovery was determined to prove the existence of active hydrocarbon systems that contain generating hydrocarbon source, reservoir and seal features along with migration and trapping mechanisms.

"Even so," Scaife noted, "the majority of the basin, particularly deepwater, has yet to be explored."

Pleasing Potential

The Andaman Sea Basin lies between and on trend with the mature hydrocarbon-producing provinces of Myanmar to the north and Indonesia to the south.

Both these areas contain world class producing fields.

Scaife emphasized that features observed on the Spectrum reprocessed seismic appear to be analogous to these fields and indicate these successful play fairways can be extrapolated into the Andaman Sea Basin frontier area.

Late Cretaceous and Eocene age sediments are reported to be the primary source rocks in the basin. They possibly are the source of the gas in the Miocene in the aforementioned discovery well.

"Biogenic gas is reported to be sourced from Neogene sediments as

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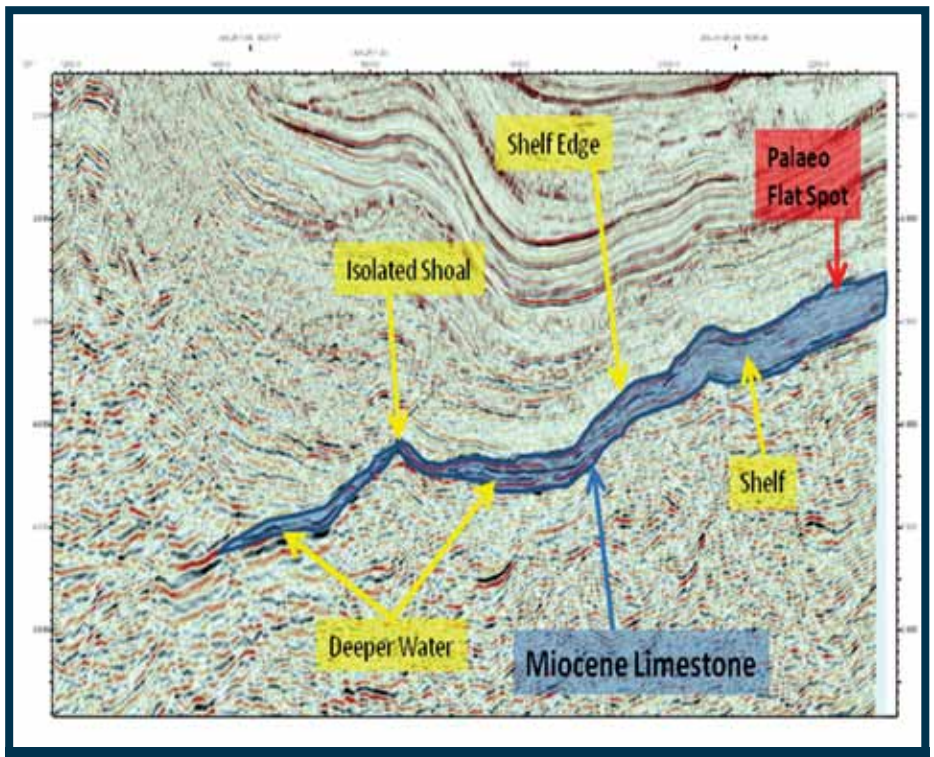

Data courtesy of Spectrum ASA

An example of limestone build-up – the basin's cap rock. The section length is 28 kilometers.

Continued from previous page

evidenced from the present day active mud volcanoes," Scaife said. "Miocene carbonates and turbidites of the Mio-Pliocene are reported to be the reservoir rocks with intra-formational shales and tight limestone of Neogene age acting as cap rocks within the basin."

Interpretation of the reprocessed data has shown that the Andaman Sea Basin harbors all of the necessary components for successful hydrocarbon exploration.

The interpretation identified potential source, reservoir (carbonates and clastics) and seal intervals and also structural and stratigraphic trapping geometries.

Scaife noted that direct hydrocarbon indicators (DHI) are observed, which include:

- Gas clouds.
- Bright and flat spots.
- Seabed pock marks.
- Vent mounds.

He added that bottom-simulating reflectors indicate the presence of gas hydrates.

No Slam-Dunk

Granted, the reprocessing program yielded significant results over the earlier processing.

But getting from there to here was no slam-dunk.

Scaif summarized the considerable challenges to the reprocessing effort:

- Data spread over a large area incorporating very varied geological terrains.
- Differences in ages and parameters of acquisition and the very sparse grid.
- Big bathymetric range from very shallow water to 3.5-plus kilometer water depth.
- Often dealing with high relief and abrupt changes in water depth.
- Structural/tectonic complexity, e.g., numerous steep dips with the angle and direction of dip varying dramatically within short distances.
- Complicated ray paths and considerable amount of data from out of the plane of the section complicating the velocity analyses and contaminating the multiples.
- Shallow reefs, rugose small-scale structures and very variable velocities scatter energy and complicate deeper imaging.

When all was said and done, the imaging was improved via:

- Reducing multiple contamination.
- Enhancing the signal-to-noise ratio by attenuating energy scattered by shallow geology.
- Improving the continuity of events.
- Enhancing the temporal and spatial resolution and, therefore the seismic character.
- Improved imaging of the deeper section.

Helium-3
from page 39

downhole conditions.

"Currently, there are no alternatives for our industry that meet all of our requirements," Roscoe noted.

"These requirements include very small size, very high detection efficiency, high count-rate capability, good gamma-ray discrimination, ability to work at high temperatures – normally 175 C and up to 260 C – and ability to withstand a high shock and vibration environment," he said.

Industry response to the helium-3 shortage includes an attempt to recycle the gas and ongoing research into possible substitutions.

"The industry is trying to develop alternative technologies to helium-3 for our environment. Until that is in place, the industry is trying to reduce the amount of gas it uses, re-use neutron detectors where possible, and recycle gas from old detectors," Roscoe said.

If the industry can't get adequate helium-3 supplies or develop workable alternatives, serious challenges could develop, Roscoe noted.

"This would result in a shortage of information to the oil companies on how to best manage and complete their reservoirs," he said, "which could have large financial implications and affect the ultimate producible reserves."

AAPG EXPLORER

The Geophysical Corner is a regular column in the EXPLORER, edited by Bob A. Hardage, senior research scientist at the Bureau of Economic Geology, the University of Texas at Austin. This month's column is the second in a four-part series on 3-D seismic design.

Next Step: Geology Guides the 3-D Design

By BOB HARDAGE

This month we continue our look at 3-D seismic design, focusing on color-coded area labeled "Part 2" on figure 1.


HARDAGE

Shallowest Target and Line Spacings

The depth of the shallowest target that must be imaged across a prospect is a key control on the geometry of a 3-D acquisition grid, because that depth dictates the distance that source and receiver lines should be separated.

If there is a shallow interface that has a known dip across a prospect, that interface should be imaged even if it is not related to a reservoir – because by making the image dip match the known dip, data processors are assured the static corrections, shallow velocity analyses and other data processing procedures that affect reflector dip and continuity have been correctly done.

In other cases, a shallow reflector may need to be imaged so it can be used to make isopach maps.

If this shallowest target is at a depth Z_1, then a 3-D grid should be structured so that for every stacking bin there are several (at least three or four, and ideally seven or eight) source-receiver pairs that:

- Are separated a distance no greater than Z_1.
- Cause reflection points to fall inside the bin.

Figure 2 is a section view showing raypaths that result when a source-to-receiver offset equals the shallow-target depth Z_1. If a source-to-receiver offset exceeds Z_1, there is a high probability that the illuminating wavefield will be critically refracted at or above Z_1 and will not provide a reflection image of the shallow target. Therefore, a 3-D design must ensure that at every stacking bin there are several source-receiver pairs that are separated a distance that does not exceed offset distance X_{min} shown on figure 2, where $X_{min}=Z_1$, the depth of the shallowest target.

An effective way to ensure this minimum source-to-receiver offset exists is to define the source-line and receiver-line spacings to be approximately the same as, or less than, the shallow-target depth Z_1. A good choice is to set the line spacing at one-half or less of the shallow target depth.

An example of one possible design is shown on figure 3. This particular geometry illustrates a common design philosophy in which the receiver-line spacing is approximately the same as the shallow-target depth, but for reasons of economy (that is, to reduce the number of source stations per square mile), the source line spacing is slightly larger.

For this design, all source-receiver pairs inside shaded area ABCD satisfy the offset restriction that results in reliable imaging of stratigraphy at, and even slightly above, depth Z_1 within that shaded area. Similar overlapping, restricted-offset areas like ABCD extend completely across this particular 3-D grid.

Thus, by answering the simple question "what is the shallowest target to preserve in the 3-D image?" a first approximation for source-line and receiver-line spacings that should be used in the 3-D field program can be made.

Deepest Target and Swath Size

The next parameter in the 3-D design is the depth of the primary, or deepest, target that is to be imaged. This depth is labeled Z_{tar} on figure 2, and the raypath picture shows the source-to-receiver offset range that is particularly critical to imaging a target at this depth involves source-receiver pairs that are separated distances that range from zero to X_{max}, where X_{max} equals depth Z_{tar}.

Larger source-to-receiver offsets up to a distance of $2Z_{tar}$ also are important for both data processing and imaging reasons; thus offsets in the range Z_{tar} to $2Z_{tar}$ also should be created by the recording swath.

When a seismic wavefield is generated at a particular source station, the 3-D recording swath is defined as that area spanned by the active receivers that record the seismic response generated at that station.

In concept, these active receiver stations

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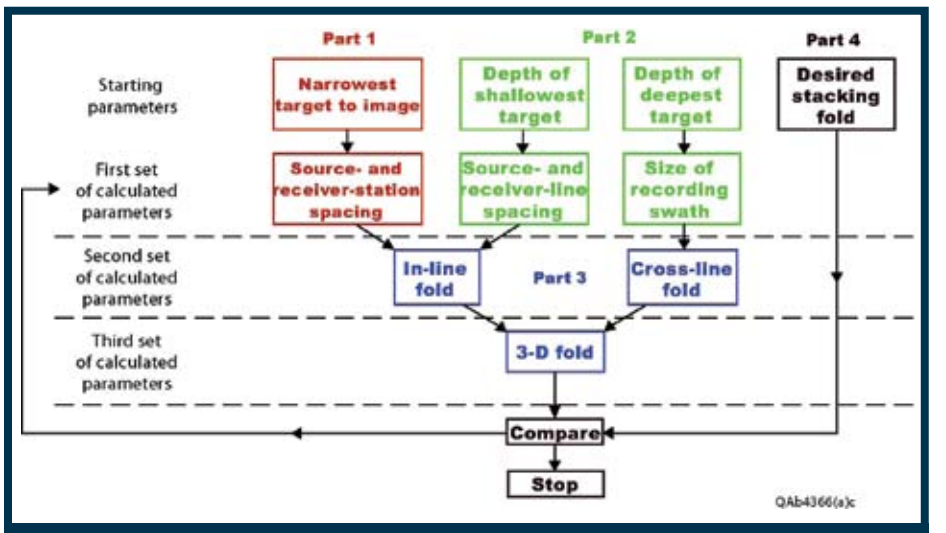

Figure 1 – Planning steps that can be followed to design a 3-D seismic acquisition geometry. This article discusses the topics identified by the outlined area labeled Part 2.

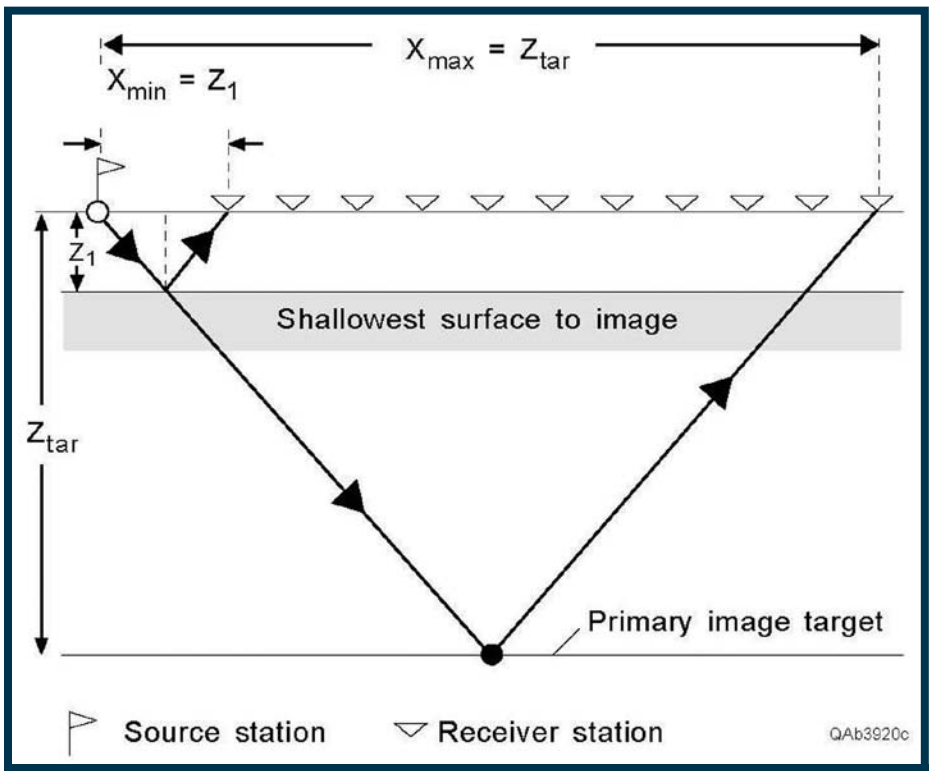

Figure 2 – Section view of Earth layering that is to be imaged. A 3-D designer needs to know two critical depths: (1) depth Z_1 of the shallowest reflector that has to be Imaged, and (2) depth Z_{tar} of the primary target to be studied. If multiple targets exist at various depths, then Z_{tar} should be defined as the depth to the deepest target. The shallow target depth Z_1 controls the source-line and receiver-line spacings, which should be no larger than the offset distance X_{min} shown here. The deep target depth Z_{tar} defines the physical size of the recording swath, which should span an area having a width of about $2X_{max}$ in both the in-line and cross-line directions.

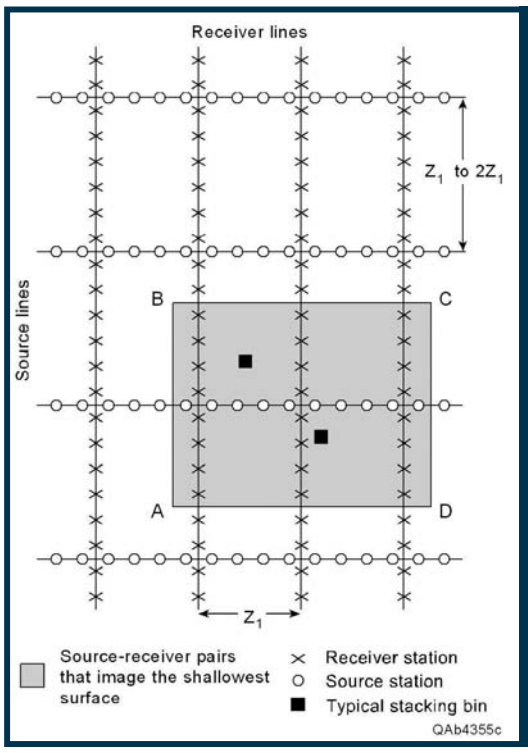

Figure 3 – An example of source/receiver-line spacings designed to image a shallow target at a depth Z_1. In this example, the distance between the receiver lines is set to a value that equals shallow-target depth Z_1. In other instances a designer may elect to set the receiver-line spacing to be $0.5Z_1$ or less. All of the source-receiver pairs inside the shaded area ABCD have offset separations that are small enough to image stratigraphy at depth Z_1. Several (three to five) source-receiver pairs can be found that cause reflection points to be positioned inside each stacking bin, such as the two bins that are highlighted, which creates a continuous, low-fold image across the shallow target. For reasons of economy, the source-line spacing often is made larger than the receiver-line spacing, as is done here, to reduce the number of source stations per square mile.

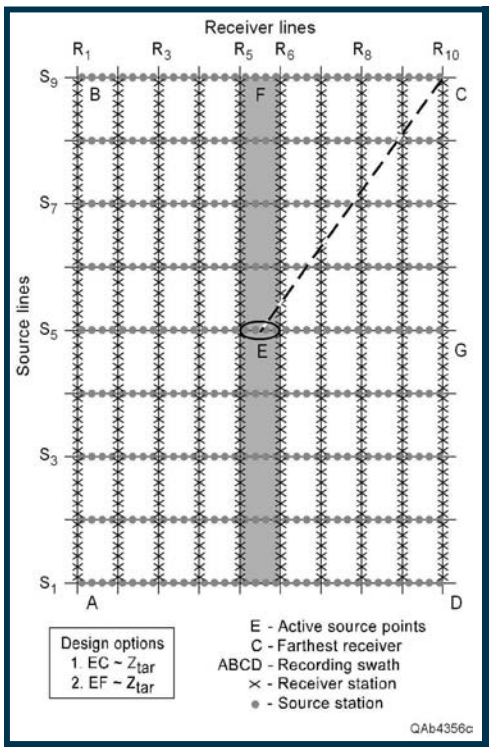

Figure 4 – Recording swath designed to image a deep target at depth Z_{tar}. The swath is the area enclosed by rectangle ABCD, and the active source stations for the swath are all of the stations on source lines S_1 through S_9 that are between receiver lines R_5 and R_6 (the shaded strip). The fundamental requirement is that there must be several source-receiver offsets that are approximately twice the magnitude of target depth Z_{tar}. This offset condition exists when (1) the active source stations are on source lines S_1 and S_2 and the receiver stations between source lines S_8 and S_9 are active, or when (2) the active source stations are on source lines S_8 and S_9 and the receiver stations between source lines S_1 and S_2 are active. Some designers set diagonal distance EC equal to Z_{tar}; others set one of the widths EF or EG equal to Z_{tar}. Either option is satisfactory. At least one dimension of the recording swath must be approximately twice as long as depth Z_{tar} to the primary (or deepest) target. The number and length of receiver lines inside the swath are controlled by the source-line and receiver-line spacings and by the channel capacity of the recording system.

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

PROFESSIONAL NEWS BRIEFS

David G. Ashton, to evaluation manager, Kuwait Energy, Salmiya, Kuwait. Previously consultant, Great Missenden, England.

Donald Burdick, to A&D manager, Laredo Petroleum, Tulsa. Previously asset team leader-Pan West, Laredo Petroleum, Tulsa.

Marcus L. Countiss, to manager-development, Plains Exploration & Development, Houston. Previously senior geophysicist, Plains Exploration & Development, Houston.

Howard Fishman has retired from Chevron after 35 years of service. Fishman resides in Heber City, Utah.

Gary S. Grinsfelder, to vice president-exploration, LeFrak Energy, Houston. Previously president, TXCO Resources, Houston.

Mark Grummon, to senior geologist, Resolute Natural Resources, Denver. Previously vice president, North American Exploration, Denver.

Greg Hummel, to senior geologist, ERG Resources, Brea, Calif. Previously senior geologist, BreitBurn Energy, Los Angeles.

Alan S. Kornacki, to geochemistry consultant, Weatherford Laboratories, Houston. Previously principal geochemist, Royal Dutch Shell, Houston.

Tim Kustic, to technical services manager, California Division of Oil, Gas and Geothermal Resources, Sacramento, Calif. Previously district supervisor, California Division of Oil, Gas and Geothermal Resources, Sacramento, Calif.

Henry M. Lieberman, to senior geoscience consultant, Canadian International Oil (USA), Houston. Previously advanced senior geologist, Marathon Oil, Houston.

Matthew R. Martin, to manager-E&P technical services, Newfield Exploration, Houston. Previously asset manager-Gulf of Mexico, Newfield Exploration, Houston.

Richard "Rich" McLean, to exploration manager, Canadian International Oil (USA), Houston. Previously exploration manager, Marathon Oil, Houston.

Jim Swartz, to general manager-operational excellence, Chevron, San Ramon, Calif. Previously asset development manager-Kern River, Chevron North America E&P, Bakersfield, Calif.

K.B. Trivedi, to principal geologist, PetroSA, Cape Town, South Africa. Previously chief geologist, Oil & Natural Gas Corp, Dehradun, India.

Candidates Add Video Comments

Video comments by candidates for AAPG office are now available online at www.aapg.org.

The comments, filmed during the recent AAPG Leadership Conference in Tulsa, show the Executive Committee candidates talking about why they accepted the invitation to stand for an AAPG office.

Biographies and individual information for AAPG officer candidates also are available online.

Ballots will be mailed in spring 2011.

The president-elect will serve in that capacity for one year and will be AAPG president in 2012-13. The vice president-Regions and secretary serve two-year terms.

Complete election campaign rules also are available online.

The slate is:

President-Elect

❒ **Edward A. "Ted" Beaumont**, independent consultant, Tulsa.

❒ **John C. Dolson**, DSP Geosciences and Associates, Coconut Grove, Fla.

Vice President-Regions

❒ **David C. Blanchard**, El Paso Egypt Production, Lasilky, Maadi, Egypt.

❒ **Stuart D. Harker**, Circle Oil Plc, Finchampstead, U.K.

Secretary

❒ **Charles A. "Chuck" Caughey**, ConocoPhillips, Houston.

❒ **Denise M. Cox**, Storm Energy, Panama City, Fla.

Continued from previous page

should form a continuous areal coverage completely around the source point and extend at least a distance Z_{tar} (the depth to the primary target) in all directions away from each active source station.

In practice, however, only approximations of this type of ideal recording swath sometimes can be created.

For example, if a square swath with side dimensions of $2Z_{tar}$ causes the number of receiver stations to exceed the channel capacity of the recording system, then a rectangular-shaped swath is commonly used, with the long dimension of the rectangle being $2Z_{tar}$ to create the required long offset distances, and the narrow dimension being as large as the channel capacity of the recording system will allow.

A typical, rectangular 3-D recording swath is illustrated on figure 4. The active source stations are all of the source points on source lines S_1 through S_9 that are between receiver lines R_5 and R_6, and the recording swath spans all the receivers inside rectangular area ABCD centered about source point E.

To satisfy the raypath requirement shown on figure 2, either the diagonal distance EC or one of the half-widths EF or EG must be approximately the same as the target depth Z_{tar}.

It is arbitrary as to which of these recording swath dimensions to set equal to Z_{tar}. The number of receiver lines included in swath dimension AD is determined by the receiver-line spacing (figure 3).

* * *

All of the first set of design parameters indicated on figure 1 now have been calculated using geology to guide the design.

The next step is to determine if these choices of source- and receiver-station spacings, source- and receiver-line spacings and recording swath size result in an acceptable stacking fold.

David Curtiss, head of AAPG's Geoscience and Energy Office in Washington, D.C., can be contacted at dcurtiss@aapg.org; or by telephone at 1-202-684-8225.

WASHINGTONWATCH

AAPG Adds Voice to Moratorium Conversation

By DAVID CURTISS, GEO-DC Director

As oil spilled from the Macondo well into the Gulf of Mexico in the days following the Deepwater Horizon drill rig explosion, the White House scrambled to respond. President Obama ordered the Department of the Interior to conduct a safety review of offshore operations and report back within 30 days. In the interim, Interior Secretary Ken Salazar announced the department would not issue new deepwater drilling permits.

The 30-day review, delivered May 27, recommended specific measures to increase safety and enhance oversight of offshore operations. These measures were codified and communicated to industry through two "Notices to Lessees and Operators" (NTL No. 2010-N05 and -N06).

The president simultaneously extended the suspension on deepwater drilling – defined as wells in more than 500 feet of water – until Nov. 30, while the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling investigated.

The move drew criticism from both industry and political leaders.

Hornbeck Offshore Services, which supports deepwater and ultra-deepwater drilling and operations, filed suit against Salazar, alleging "the federal government's imposition of a general moratorium on deepwater drilling for oil in the Gulf of Mexico was imposed contrary to law."

"[T]he Court is unable to divine or fathom a relationship between the findings [of the 30-day review] and the immense scope of the moratorium," wrote Judge Martin Feldman of the U.S. District Court Eastern District of Louisiana in his ruling. The moratorium was not in the public interest, the judge concluded, and granted a preliminary injunction against it.

CURTISS

> **"An offshore drilling moratorium is a blunt policy tool that is more destructive than beneficial."**

Many Gulf Coast leaders agreed.

"During one of the most challenging economic periods in decades, the last thing we need is to enact public policies that will certainly destroy thousands of existing jobs while preventing the creation of thousands more," wrote Louisiana Gov. Bobby Jindal (R) in a letter to President Obama and Secretary Salazar. He urged enforcement of existing regulations and emphasis on safe operations.

Sen. Mary Landrieu (D-Louisiana) acknowledged there is no risk-free energy production, but called on the administration to implement new drilling practices, such as those suggested in the 30-day review report, rather than issue a blanket moratorium.

"I believe that we can demonstrably improve the safety of deepwater drilling without shutting down the Gulf Coast economy for more than six months," Landrieu said.

In response to the barrage of criticism, both the White House and the Interior Department indicated willingness to consider an earlier lifting of the drilling suspension.

"I remain open to modifying the new deepwater drilling suspensions based on new information," said Secretary Salazar, "but industry must raise the bar on its practices and answer fundamental questions about deepwater safety, blowout prevention and containment and oil spill response."

The administration issued a revised moratorium in July, after Judge Feldman's ruling, focusing on the technical specifications of the drilling operation rather than water depth. And as part of this process, Secretary Salazar instructed Michael Bromwich, director of the Bureau of Ocean Energy Management, Regulation and Enforcement, to conduct fact-finding meetings across the country on offshore safety and best practice.

Independently, the National Commission is also reviewing the use of moratoria. It asked the Bipartisan Policy Center (BPC), a Washington, D.C., think tank, to assist with the assessment.

BPC in turn invited a diverse group of stakeholders to respond to a questionnaire on aspects of offshore exploration, production and safety practices.

AAPG President David Rensink responded on behalf of the Association, providing geological context, discussing how oil and natural gas operators manage risk and uncertainty, and offering AAPG's view on the use of moratoria.

"An offshore drilling moratorium is a blunt policy tool that is more destructive than beneficial," Rensink wrote. "Its high cost has been evident this year, as the moratorium imposed in May exacerbated the already substantial economic harm experienced along the Gulf Coast from this tragic event. Consequently, AAPG believes that future federal plans for spill response preparedness should not include the use of moratoria."

In its report to the National Commission, BPC stated the moratorium gave government and industry opportunity to review and enhance operational and safety practices. The changes initiated after the 30-day review, together with on-going improvements, should be fully implemented and enforced. If done, this "new regime will provide an adequate margin of safety to

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Registration Opens for ATC

Registration is now open for OTC's inaugural Arctic Technology Conference, created to keep energy professionals on the cutting edge of exploring and producing in the world's harshest climate.

ATC is set for Feb. 7-9 in Houston.

The technical presentations will feature speakers from a dozen countries – Canada, Denmark, Finland, Germany, Japan, Netherlands, Norway, Russian Federation, Singapore, Sweden, United Kingdom and the United States – representing top E&P companies and covering seven key topical areas: Resources; Exploration Drilling; Production Drilling, Facilities and Export; Physical Environment; Logistics and Marine Transport; and Regulatory and Environment.

"ATC will provide a world-class venue to present creative solutions to this challenging Arctic arena," said Pierre-Alain Delaittre, chair of the ATC Technical Program Committee. "With a highly specialized technical program of over 150 presentations, high-level speakers, networking events and exhibition, ATC will provide opportunities for gaining additional experience and expertise to oil and gas professionals who attend."

ATC was created after the the U.S. Geological Survey in 2008 completed an assessment of undiscovered conventional oil and gas resources in all areas north of the Arctic Circle, revealing unlimited opportunities for companies and countries that can find solutions to the Arctic's many challenges.

The agency determined that 90 billion barrels of oil, 1,669 trillion cubic feet of natural gas and 44 billion barrels of natural gas liquids have the potential of being discovered in the circum-Arctic.

About 84 percent of the entire resource is expected to occur in offshore areas.

ATC is built upon OTC's successful model of multidisciplinary cooperation and contribution, with 14 technical societies and organizations – including AAPG – working together to deliver the world's most comprehensive Arctic Event.

"ATC is a truly international event focused on the cutting-edge technologies and ... emphasizing respect for the people and the environment of this harsh region," Delaittre said.

For more information or to register go to ArcticTechnologyConference.org.

Washington
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responsibly allow the resumption of deep water drilling in the Gulf of Mexico," the report concluded.

* * *

As I write this in early September, it is unclear whether the administration will lift the drilling suspension before Nov. 30. But if the moratorium ended tomorrow, what effect would that have?

Would business resume as if nothing happened?

Former Shell President John Hofmeister appeared on Bloomberg Television on Aug. 30 warning that it could be 1-1/2 to 2 years before a new deepwater well is drilled. He fears that early permits will be challenged in court, leaving the judiciary to decide whether drilling will proceed. And the impact of new regulations could have a chilling effect on offshore E&P activity, resulting in decreased Gulf oil production.

Lifting the moratorium is necessary, but only the first step. There are many policy decisions, from permitting and environmental regulations to taxes, needed to ensure robust domestic oil and natural gas production in the Gulf of Mexico.

These decisions ultimately require public acceptance. According to Rasmussen, public support for offshore drilling ranged from 56 percent to 64 percent this summer, with 53 percent of voters supporting deepwater drilling.

That's good. Our collective challenge is to educate the public and policy makers about what good policy decisions are.

It's a discussion we need to have.

Regions and Sections is a regular column in the EXPLORER offering news for and about AAPG's six international Regions and six domestic Sections. Contact: Carol McGowen, AAPG's Regions and Sections manager, at 1-918-560-9403; or e-mail to cmcgowen@aapg.org.

Horn River Basin Keeping Canada Hot

By CAROL McGOWEN, Regions and Sections Manager

Canada's Horn River Basin has been described as significantly larger than the Barnett shale area in Texas, which currently produces three billion cubic feet per day. Third-party estimates predict the Horn River area could hold 50-100 trillion cubic feet of natural gas, making it the hottest resource play in North America.

But anyone working in western Canada can attest that production and development of this resource is costly – and when it comes to transporting the resources to market, northeastern British Columbia is at the end of the proverbial pipeline.

What makes the Horn River competitive with other North American shale gas plays?

British Columbia offers a series of royalty credit programs that are helping to incentivize drilling activity in the province. And although most drilling sites are in remote locations, British Columbia's reinforced road construction methods and unique well site drilling pads facilitate year-round drilling.

Plans for new pipeline construction projects and export facilities could guarantee improved transport to global markets.

In August, 16 companies doing business in British Columbia received royalty credit awards under the Infrastructure Royalty Credit Program totaling $115.6 million. They were Apache, Canbriam Energy, Cinch Energy, CNRL, Crew Energy, Encana, Encana-Questerre, Ironhorse-Grizzly, ISH Energy, Nexen, Pavillion, Ramshorn, Shell, Talisman and Taqua North.

Nexen's summer frac operation in the Horn River Basin; new pipeline construction projects and export facilities in the region could guarantee improved transport of gas to global markets.

British Columbia's Minister of Energy, Mines and Petroleum Resources, Bill Bennett, instituted a series of innovative royalty deductions provided to companies in exchange for company investment in road and pipeline infrastructure projects that improve access to underdeveloped areas in British Columbia.

The royalty deduction programs provide incentives for infrastructure development, deep wells, marginal wells, remote drilling locations and wells drilled during the summer. These incentives are designed to provide enough profit margin to move technically complex and expensive-to-produce wells to economic viability, thereby making shale plays in British Columbia more competitive with other North American gas plays.

Year-round drilling is made possible with special drill site pads designed for the British Columbia climate and its pervasive "muskeg" environment – thick boggy layers of organic peat that forms a hard frozen surface in the winter but in summer are soft and wet. The credits also apply to reinforced road construction projects and well-site pads, and facilitate doing business during British Columbia's wet, summer season.

The province encourages energy industry investment in general, and Bennett points to steps taken by the government and the ministry to streamline regulatory processes in helping to ensure a favorable return on investment in British Columbia's natural resources.

"Shale gas plays in northeastern British Columbia may be a long way from market," Bennett acknowledged, "but the British Columbia government has taken an open approach to ensure the country's resources are competitive in North American markets."

Evaluation and Strategies

Gas producing Devonian-Mississippian age strata in northeastern British Columbia have been described as thermally mature silicious shales. Shale gas production from the Horn River formation is well documented, along with the laterally equivalent Besa River, Muskwa and Fort Simpson.

Formation thicknesses of 500 feet and more represent enormous reservoir potential.

Rocks that are both silica rich and that have total organic content (TOC) of 5-plus percent are considered most favorable for shale gas reservoir exploration due to the rock propensity for enhanced fracturing of brittle, organic-rich and silica-rich facies, according to the integrated formation evaluation report of Ross and Bustin, University of British Columbia (AAPG BULLETIN, January 2008).

In other words, rock intervals that have higher carbonate and silica content may be expected to respond favorably to fracture stimulation.

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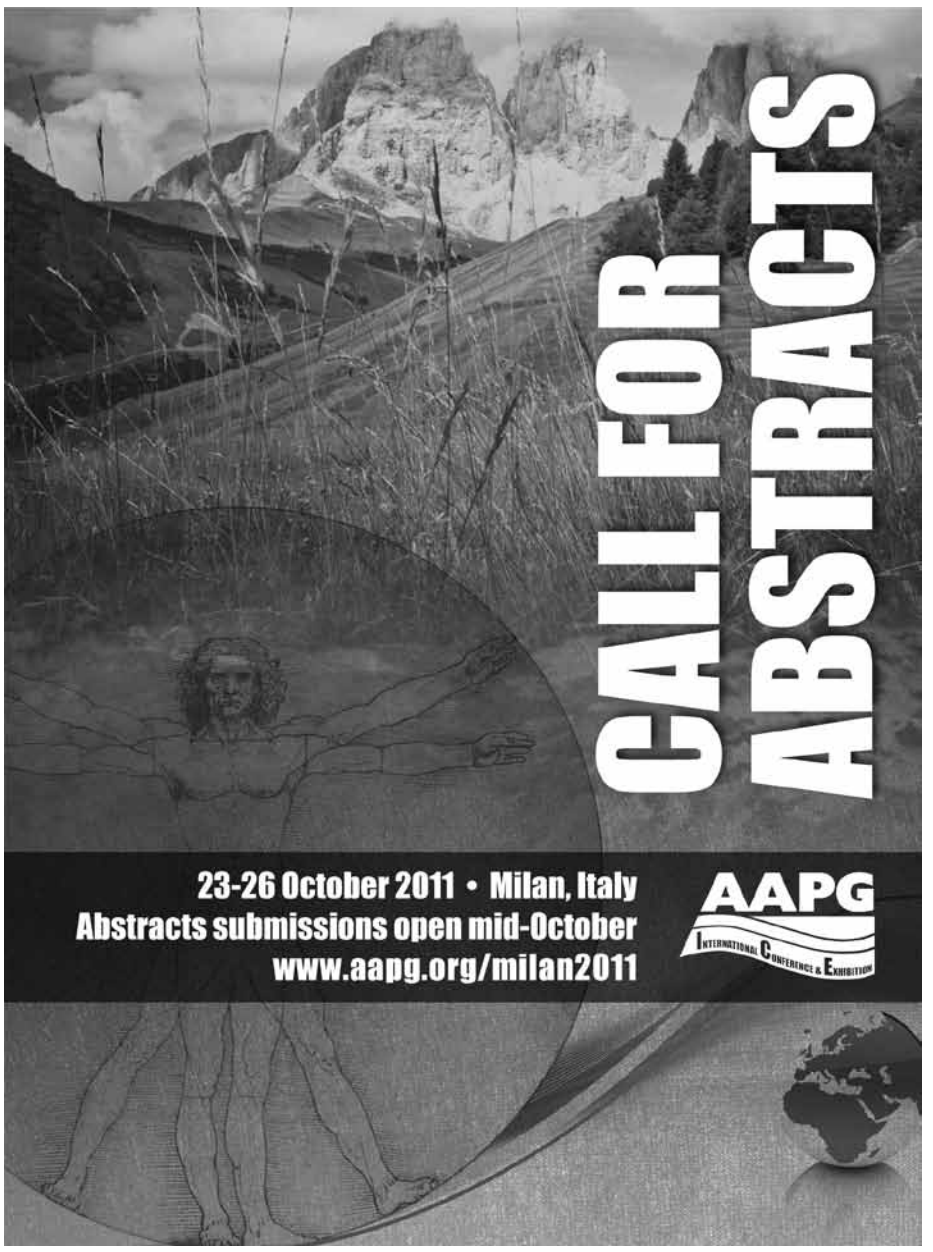

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Article highlights include:

Methane from biodegraded petroleum

Alexei V. Milkov

Methanogenic biodegradation may best explain the observed distribution and properties of fluids in the shallow reservoirs of five representative fields in the West Siberian Basin. Direct and circumstantial evidence in support of this hypothesis is presented.

Timing implications and petroleum relationships

Andrés Mora, Brian K. Horton, Andrés Mesa, Jorge Rubiano, Richard A. Ketcham, Mauricio Parra, Vladimir Blanco, Diego Garcia, and Daniel F. Stockli

The migration of deformation during Cenozoic orogenesis in the Eastern Cordillera of the Colombian Andes is examined in this paper. Orogenic activity occurred in this region from late Paleogene to early Neogene, contradicting previous interpretations for late Miocene activation of the modern Eastern Cordillera.

Benthic sediment facies maps

Stephen E. Kaczmarek, Melissa K. Hicks, Shawn M.Fullmer, Kelley L. Steffen, and Steven L. Bachtel

Unlike conventional maps, Landsat-derived maps show a realistic level of complexity. Statistical algorithms of Landsat data coupled with sediment data provide a cost and time-efficient method for quantitatively mapping spatial variability of depositional facies in modern carbonate environments.

Updating hydrocarbon resources

Paul C. Hackley and Thomas E. Ewing

This paper describes the conceptual geologic model used to define assessment units of the Claiborne Group. The great bulk of undiscovered hydrocarbon resources are predicted to be nonassociated gas and natural gas liquids contained in deep, overpressured, complex outer shelf and basin floor reservoirs.

What is the Value of Old Data?

By BARRY FRIEDMAN, EXPLORER Correspondent

Imagine you have a collection of old eight-track tapes in a box in the attic; unfortunately, your eight-track player is long gone, sold in a garage sale in the late '70s and by now, no doubt, in a landfill.

The music in that box, though – some brilliant, some forgettable – is still important to you, still helping to unravel adolescent and philosophical mysteries.

The key thing is this: the music is still good.

Making matters worse, you never transferred any of it to cassette, never burned it to a CD, didn't upload it to an MP3. You can't find it on iTunes and the guy at Best Buy laughed when you asked whether anyone was selling eight-track players anymore.

What do you do now?

Gordon Beattie, a geologist now based in Kilmarnock, Scotland – about 25 miles south of Glasgow – believes the petroleum industry is facing a similar dilemma.

Beattie was both a drilling fluids engineer, mudlogger and wellsite geologist for MB Petroleum Services during the past four decades, but now he has a new mission: Making sure others see that data preservation is a crucial concern that must be addressed.

The industry, he says, soon will be losing important historical data because there will no longer be equipment available to decipher it.

It's a novel on a floppy disc; a wedding shot on an old reel-to-reel.

It's Back to the Future.

And it's a problem that's been concerning him for 40 years.

"I was leaving a well site," he recalled, "at the end of a well, when the tool pusher stopped my truck, and said, 'You had better take this.'

Beattie remembers the moment with a clarity of something that occurred weeks ago.

"He passed me a thick roll of Geolograph charts," Beattie said. "At my base, I opened this roll, and found that this contained not only records from this well and earlier work for the same client, but records from earlier clients.

"This led me to question how much other data had been dealt with in such a cavalier manner."

In other words, he began thinking about all the geologic work out there – how accurately was it recorded, catalogued, protected? And where is it now?

The Downfall

Admittedly, Beattie knows there's not much he can do in technical terms to help save this day.

"I do not have any great knowledge of data storage systems," he said, "but I was hoping that creating an interest might

Continued on next page

Preservation of Rock Material a Daunting Task

AAPG has long been involved in the preservation of geologic data – an effort that now continues through the Preservation of Geoscience Data Committee.

The committee's chairs are Michael D. Laine, with the Utah Geological Survey in Salt Lake City, and Beverly Blakeney DeJarnett, with the Houston Research Center at the Bureau of Economic Geology in Austin, Texas.

And they agree with Gordon Beattie's concern.

"There is a serious need ... for a strong push to preserve all kinds of geoscience data – not just well site information, but rock samples such as cores and cuttings, as well," DeJarnett said. "Without the proper preservation of much of this rock material, the geosciences will truly be at a disadvantage in the future."

Industry technologies alone "have evolved at such an incredibly rapid pace," she said, "and we can now do analyses that many people never even imagined on older, already acquired cores and cuttings."

But without the rock material to begin with, "none of this would be possible."

New technologies utilized on older data already have revitalized many old oil or gas fields and have contributed to the discovery of new resources, she said.

"We as geoscientists do not know what questions will become critically important in the future – we don't know what questions will be asked or what problems will need to be solved," she said.

"Without preserving the already acquired geologic material and associated data, we will have to start from scratch."

As an example, DeJarnett said "the very popular concept of CO_2 sequestration owes part of its success to the ability of geoscientists to re-analyze existing cores and other data to quickly assess the feasibility of CO_2 sequestration for certain reservoirs and regions."

But DeJarnett has something more urgent to add to the situation – namely, her committee's mission, which is to promote collection, preservation and utilization of geoscience data and bring greater awareness of these issues to the public.

The committee accomplishes this through:

- Annual meetings, where geoscientists share their various perspectives on problems associated with, best practices for and innovative ways of finding funding for geoscience data preservation.
- Working closely with other entities involved with geoscience data preservation, such as the state geological surveys that are often the repositories for geoscience data (such as geophysical logs, field notes, cores, cuttings and other geologic samples).
- Working with and disseminating information from the U.S. Geological Survey and other federal bureaus involved with the same problem.

"We HAVE to make this preserved data and rock material accessible to the geoscience community," DeJarnett said. "Otherwise, what good is it?"

– BARRY FRIEDMAN

Continued from previous page

bring someone with experience in this field forward.

"I am hoping (to) instigate a trawl through the memories of some AAPG members for old data – and to introduce some of the younger members to a variety of material they have not considered," he said.

Part of the problem, he believes, had to do with the sheer volume of the activity back then.

"During the boom of the 1970s-'80s the average rig count peaked at almost 6,000," Beattie observed. "Since then the average has fallen to below 3,000."

But because of that boom, much of the record-keeping may not have been as professional as one might have hoped.

"While the vast majority of this activity was carried out by well-established oil companies in proven areas," he said, "there was some work done by short-lived exploration groups."

And he talks about what he calls the "doctors and lawyers oil companies:" "The scale of novice personnel recruitment and technical innovation meant there was a variation in appreciation of results and in data storage."

The point, he says, was that not all exploration or record keeping was done to or with precise instructions.

More problematic is that this "treasure trove" of information, as he calls it, now needs to be examined or transferred before the storage technology is completely lost and nobody can remember how to access the computer languages used.

"The information collected at that time is still relevant," he emphasized, "but is held in a diversity of formats – cassettes, HP cartridges, large floppy discs, tapes, etc. There is also raw data, in the form of Geolograph charts, IADC reports, well logs and rig diaries."

Back to the Future

Getting back to that fortuitous meeting with that tool pusher and the information handed him, he said, "Indeed there were many wells drilled with only Geolograph and microscope giving running data."

And knowing not just how the data was collected but also its location today is "anyone's guess.

"In some locations they went to specified storage, North America and Europe," but he says not all, joking at one point that some might be upstairs in some Chinese restaurant.

So what can be done about it and, equally as important, who could and would do the necessary transfers and updating?

"The gap could be filled by a trawl carried out (e.g.) by members of AAPG or PESGB, who can remember where the material obtained from, and (more importantly) where it was stored," he suggested.

He also believes, in the case of electronically stored data, there may be a case for a specialized unit being able to access and apply current standards to early material.

"There was such pressure to reach the target formations that smaller, more marginal shows were frequently overlooked," Beattie said. "These may only be discovered by examining the raw data obtained during drilling."

Until then, he seems to be saying, important geologic information, like your old Janis Joplin "Pearl" eight-track, will sit in an attic and a truck or a Chinese restaurant, waiting to be unearthed.

Canada

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Thanks in part to the credit program, Nexen Inc. has doubled its position in northeastern British Columbia to 90,000 acres – 10 percent of the company's global holdings.

Ron Bailey, Nexen's general manager for shale gas, describes the Horn River Shale as having "great rock quality – 50 percent thicker even than the Barnett."

Bailey evaluates shale gas reservoir rock by five criteria:

- Gas in place per section.
- Estimated EUR per well.
- Fracability – the Horn River Shale is a more fracable reservoir rock due to its higher silica content, two to three times greater than the Barnett Shale.
- Gas quality – this is a negative factor in the Horn River Shale, having 10-12 percent CO_2 that must be extracted before pipeline transport.
- Reservoir productivity – the Horn River is highly productive.

"Nexen's interest in the area has increased as we have learned more about production strategies," Bailey said. "And by drilling larger programs, our costs have decreased while our confidence has increased."

Nexen will soon deploy an eight-well drilling pad with an average of 18 fracs per well. According to Bailey, "Our frac program achieved an industry leading pace of 3.5 fracs per day."

Pipeline Infrastructure

New pipeline construction projects are now under way or planned to connect British Columbia shale gas resources to global markets.

TransCanada kicked off construction Aug. 6 on the first pipeline to cross the Alberta-British Columbia border. The Groundbirch pipeline project will connect natural gas supplies in the Horn River Basin in northeast British Columbia to the Alberta system. The $200-300 million project is scheduled for completion by November 2012.

A planned Pacific Trail Pipeline will move gas from northeast British Columbia to Kitimat, British Columbia, where the Kitimat LNG export terminal will open to the rapidly growing economies of the Asia Pacific export markets.

Kitimat's terminal is approximately 400 miles north of Vancouver, offering a shorter, less expensive shipping route across the north Pacific. Natural gas will be cooled and liquefied at the terminal for export via ship to growing, natural gas markets in South Korea, Japan, China and Southeast Asia.

"When completed, the Kitimat LNG export terminal will provide a new market-demand outlet for British Columbia, a critical factor in the commercial development of the Horn River shale gas play," said Mike Dawson, president of the Canadian Society for Unconventional Gas.

Kitimat is designed to be linked to the pipeline system servicing Western Canada's natural gas producing regions via the proposed Pacific Trail Pipelines, a $1.1-billion (Canadian), 300-mile (463-kilometer) project.

No cost for new members

Members Offered Disability Insurance

AAPG's Committee on Group Insurance recently announced a "no-cost" new member disability insurance benefit for new U.S. members under age 50 who have graduated from college.

Terry Hollrah, committee chair, called the new benefit, which became effective June 1, 2010, "a tangible and very personal enhancement to AAPG membership."

There is no cost to the new member or AAPG for this benefit for the initial six months of coverage. This is very similar to the "no cost" $30,000 Group Term Life Insurance benefit which has been provided to new members for many years.

Hollrah said AAPG is now one of the very few national professional associations that provide new members with two valuable types of coverage – term life, and disability income insurance.

The new member disability income benefit provides $600 of monthly protection for up to two years beginning on the 61st day of total disability. Coverage is guaranteed issue with no exclusion for pre-existing conditions.

Benefits can be increased, subject to customary underwriting requirements.

New members can renew both the term life and disability income plans as long as they retain their membership and pay the renewal premiums, which are payable after the "no-cost" coverage periods expire. These insurance benefits can be valuable because they are personally portable throughout a member's professional career, regardless of employer changes.

For more information contact AAPG's GeoCare Customer Service Department toll-free at 1-800-337-3140, or e-mail geocarebenefits@agia.com.

GCAGS' 60th Meeting Set in San Antonio

A varied technical program that examines both the onshore and offshore activity and potential of the prolific Gulf Coast region has been planned for the AAPG Gulf Coast Association of Geological Societies' annual meeting, set Oct. 10-12 in San Antonio.

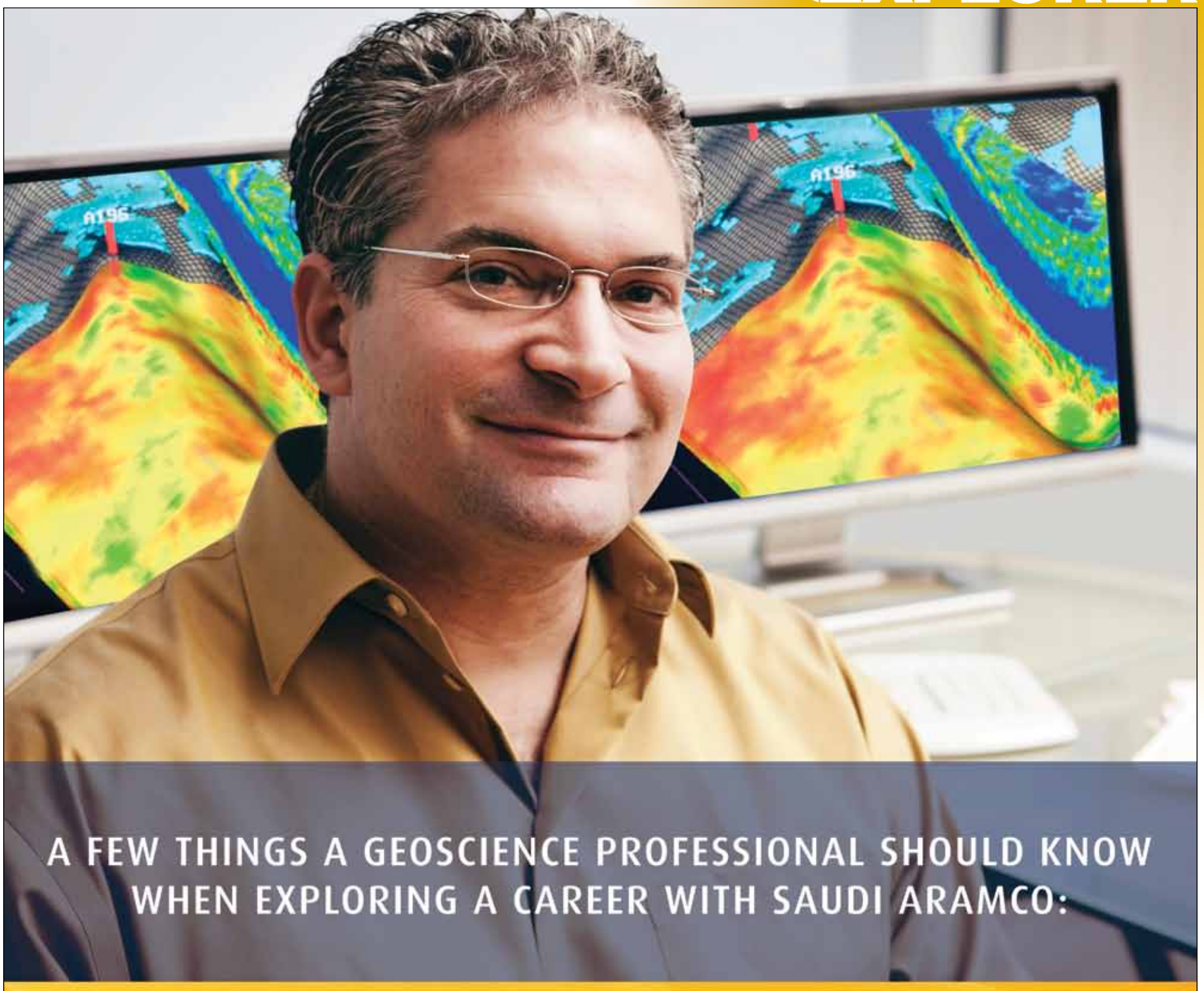
The theme for the meeting – GCAGS' 60th annual – is "Weathering the Cycles." Also meeting will be the Gulf Coast Section of SEPM.

The technical program will include a special daylong Stricklin Symposium on Tuesday, Oct. 12, titled "Forming and Filling the Gulf of Mexico Basin: Triassic, Jurassic and Cretaceous Tectonics, Source Rocks and Petroleum Systems."

Other technical sessions include Organic Shales of the Gulf Coast – Controls On Reservoir Quality and Producibility; Carbon Sequestration; Water for A Growing Region; Integrated Answers in Subsurface Exploration for Shelf-to-Ultradeep Opportunities; and Preparing for the Crew Change in the Geoscience Work Force.

The program also includes an opening session featuring AAPG President Dave Rensink and a keynote address by past AAPG president Scott Tinker, plus two luncheons.

For more information go online to www.gcags2010.com/index.html.



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AAPG FOUNDATION

ATTENTION! AAPG Foundation is awarding $181,000 to students for the 2011 Grants-in-Aid Program!

In the Spring of 2010, the AAPG Foundation awarded $203,000 to students from around the world. These awards were used to foster scientific research and advance the science of geology. Over 300 applications were submitted to the program and 84 grants were awarded.

Over the past two years, on average, only applicants in the top 25% have been awarded a grant for their thesis research. How can you increase your odds of getting funded? Check out the list below. Be sure to visit http://foundation.aapg.org/gia/ for more details and to apply by January 31, 2011.

Top 10 Ways to Increase Your Chances of Getting Funded by an AAPG Grants-in-Aid

- Make a connection to oil & gas exploration, production, remediation, energy minerals, coal or uranium - any connection at all.
- Avoid fancy formatting or bullets. These get lost in translation.
- Have a friend, colleague, mentor or professor read through your grant proposal. If they catch anything significant, be sure to make changes before submission. Ask a non-geoscientist (Mom? Roommate?) to read for clarity.
- Keep your proposal simple. You don't need funding for every aspect of your project, so focus only on those aspects that require funding.
- Be sure to frame your proposal within the broader topic under study. You're chipping away at a mountain – describe the mountain.
- Be specific about how the award will be spent. Put some thought into it; add some color. Write as if you've already received the funding and tell us what you're going to buy.
- In the budget: follow the instructions, be thorough and accurate and don't add padding. Please be forthcoming about any additional sources of funding and/or attempts at funding from other avenues. This shows a financial need and a willingness to pound the pavement, leaving no stone unturned.
- Do everything in your power to get an official transcript to AAPG Foundation, from every college or university you've attended the past two years. Do this step early to give your school time to process your request.
- Impress upon your advisor that a thorough, honest assessment of you and your project is in his/her best interest, too. Ask to see their assessment before they submit it. They may say "No," but it doesn't hurt to ask. Besides, if they are afraid to tell you what they think of you or your project, maybe you have the wrong advisor.
- Compose your text offline in a text editor that has a spell check function.

Jennifer Rothfuss – 2010 GIA recipient

AAPG FOUNDATION

For more information, contact
Angela Taylor-Shepherd, Program Coordinator
ataylor@aapg.org, 1-888-945-2274 ext. 664

Natalie Adams has been named manager of the AAPG Foundation. She previously worked in fundraising for Oral Roberts University in Tulsa, as alumni director, executive director of the Alumni Association and serving on the Alumni Foundation Board. She also has served on the board for the Alzheimer's Association.

FOUNDATIONUPDATE

Gifts Make Impact

By NATALIE ADAMS, AAPG Foundation Manager

The AAPG Foundation provides vital funding to the Association in support of educational opportunities plus the dissemination of knowledge and information on key aspects of geosciences and petroleum geology around the globe.

This would not be possible without the generosity of remarkable individuals like you. Your contributions allow us to reach and impart knowledge to today's young geoscientists, which is critical to the success of the business of petroleum.

ADAMS

Philanthropy is defined as "goodwill to fellow men," and especially "an active effort to promote human welfare." The AAPG Foundation has received donations from some very charitable individuals, and we are charged with balancing those resources among our many valued programs.

With your gifts, the AAPG Foundation will continue its stewardship for the betterment of the science and the profession of petroleum geology.

AAPG has a long history of advancing the science of petroleum, and is a leader among geoscientific societies. This organization has inspired so many of our industry's professionals from their humble beginnings when they were introduced to AAPG, many by their college advisers.

Your gift to the Foundation represents your desire to reciprocate for AAPG's continued availability through a long and rewarding career and a lifetime of esteemed friendships.

The Foundation's financial campaign, "Meeting Challenges … Assuring Success," is moving closer to the $35 million goal, with the latest numbers coming in at $28,455,910.

Your help is needed. If AAPG has provided services and benefits that have been instrumental in your professional growth and your desire is to see future generations gain from this culmination of vast experience and passion for the earth sciences, then now is the time. AAPG plans to be well-positioned for the challenges of the future.

Partner with AAPG today.

For information on how your gift can make the greatest impact, go to AAPG.org and click on Foundation, or contact Natalie Adams, Foundation manager, 918-560-2644, or e-mail nadams@aapg.org.

Contributions to the AAPG Foundation are tax deductible for persons subject to U.S. income tax.

Foundation (General)
Audrey W. Adams
Matthew D. Adams
Michael M. Adams
Enrique Aguilera-Hernandez
John Alexander
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William Casey Armstrong
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George Robert Bole
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Howard Allen Sykes
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Publication Pipeline Fund
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E.F. Reid Scouting Fund
Gary Charles Robinson

Visiting Geoscientist Endowment Fund
Tako Koning

***Since 1967**, the AAPG Foundation has worked diligently to provide support for the AAPG Foundation's many funds and programs. The ambitious financial campaign, "Meeting Challenges…Assuring Success" has a simple and direct goal – to raise funds to support charitable, educational and scientific activities related to the geosciences.*

Your contributions enable the AAPG Foundation to provide stable support for qualified programs and requests – even during economic downturns.

- *Dissemination of Science*
- *Emerging opportunities*
- *Student/Universities*
- *Education / Public Outreach*
- *Youth Education & Activities*

For a list of programs, go to http://foundation.aapg.org/programs.cfm

Please consider making a gift or a pledge today.

$35 million campaign goal
Funds raised since July 1, 2005 - $28,449,910
In pledges and contributions

Ways to give -
- *Online, at foundation.aapg.org*
- *By phone, 1-888-945-2274, ext. 644*
- *By mail, P.O. Box 979, Tulsa, OK 74101*

All donor names will appear in an upcoming issue of the Explorer.

To discuss the area of greatest impact of your gift, call Natalie Adams, Foundation Manager, 1-888-945-2274, ext. 644.

Meeting Challenges
ASSURING SUCCESS

AAPG FOUNDATION

WWWUPDATE

AAPG, PTTC Combine For Online TECHPLACE

By RON HART, Datapages Manager

It's all about the reservoir.

Every development geologist knows – once you find it, you have to produce it. And that sometimes presents some non-traditional challenges.

Since the early 1990s, The Petroleum Technology Transfer Council (PTTC) has bridged the gap between larger, technology-rich companies and the smaller operators who depend on partners and consultants for the latest technology. PTTC has been a conduit for government-sponsored research to the independent companies who operate in areas with marginal economics.

PTTC was designed to help the people who need it the most and – through a 20-year program of workshops, articles, newsletters and telephone services – PTTC has introduced thousands of "mom-and-pop" energy companies to new ideas for better production and best practices.

All that is now online.

TECHPLACE is a new online information resource provided by the PTTC and AAPG/Datapages. This cooperative effort captures and delivers technology insights from PTTC's historical activities that can be used to make important technology decisions that positively affect your company's bottom line.

TECHPLACE allows users to access workshop summaries and workshop notebooks, browse past issues of the PTTC *Network News* plus see upcoming PTTC and other events of interest.

A 12-month subscription to TECHPLACE is $195 – less than the cost of a single workshop. And users can search-and-purchase single workshop summaries via a pay-per-view option, without a subscription, at techplace.datapages.com.

The basic unit of the online service is the workshop summary. More than 1,500 workshops have been produced since PTTC began, and most of the information is still relevant today. More than 100 of these same workshop summaries have been condensed into executive summaries, which offer an overview of the same information in three to six pages and also are available.

All workshops are categorized into four main topic areas:

- Exploration.
- Reservoir and Development.
- Operations and Production.
- Drilling and Completion.

You may search the entire collection or hone your search to one of these categories.

TECHPLACE plans to grow by adding content, just like its older sibling, Datapages' Combined Publications Archives database. Specializing in secondary and tertiary recovery, reservoir engineering and geological E&P subjects, TECHPLACE hopes to host a number of partner collections apart from the geoscience focus of Datapages' other offerings. Check it out today at techplace.datapages.com.

INMEMORY

James A. Blaha, 81
Littleton, Colo., July 17, 2010
Jeffrey A. Boyer, 60
Katy, Texas, June 22, 2010
Albert Chauvin, 85
Jacksonville, Texas, July 16, 2010
Doyle William Davis, 86
Oklahoma City, Aug. 13, 2010
Noel Henry John Frith, 59
Lindfield, Australia, April 14, 2010
William Lewis Grossman, 95
San Marcos, Calif., Jan. 18, 2010
James Hill Hafenbrack, 90
Aurora, Colo., Aug. 4, 2010
Violet De Pena Y Lillo, 87
Miami, Fla., Aug. 15, 2010
Edmund Louis Russell Jr., 83
Bakersfield, Calif., July 13, 2010
Charles Philip Walters (Life '46)
Manhattan, Kan.
Robert M. Wynne, 80
Midland, Texas, July 24, 2010

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


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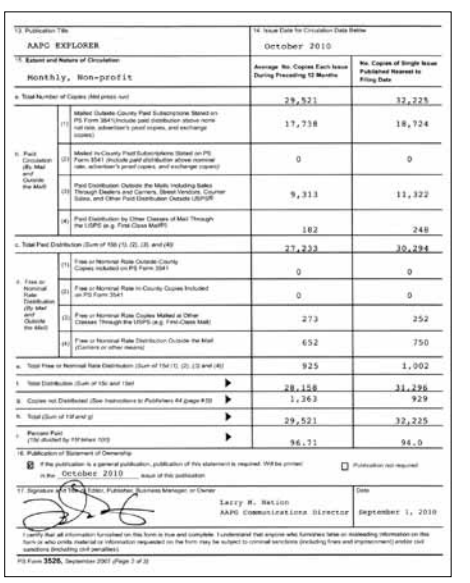
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	(2) Mailed In-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	0	0
	(3) Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS®	9,313	11,322
	(4) Paid Distribution by Other Classes of Mail Through the USPS (e.g. First-Class Mail®)	182	248
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f. Total Distribution (Sum of 15c and 15e)		28,158	31,296
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I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).
PS Form 3526, September 2007 (Page 2 of 3)

8TH ANNUAL

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Fax: 918-560-2678
E-mail: educate@aapg.org
Download a registration form at:
www.aapg.org/education/wec.cfm

Tuition for the week:

	Price through 1/31/2011	Price increase after 1/31/2011
AAPG Members	$1695	$1795
Non Members	$1795	$1895
Individual Courses	$450/day	$500/day

(Your five-day badge can be transferred to a friend or colleague if you can't attend all five days.)

SIGN UP NOW!

SAVE $200 BY BECOMING AN AAPG MEMBER AND REGISTERING BEFORE JAN. 31st

Pay Dues Online

By VICKI BEIGHLE, AAPG Membership Manager

Here's an important reminder for all AAPG members: You can pay your dues at any time by going to our online site at www.aapg.org.

Here's why keeping your membership current can be one of the best professional moves you can make:

- Members receive discounts throughout the year, including meeting registrations (10 percent or more) and publication purchases (25 percent or more).
- Members automatically receive the EXPLORER and BULLETIN as part of their membership benefits – a bargain that would cost more than five times more than the highest dues level for non-members.
- Our member benefits package provides access to a variety of career services, including a graduated dues structure, based on the member's individual ability to pay; networking opportunities; conferences/exhibitions; training; job/resume posting service; member registry; and the latest information, news and technology within our industry.

Our goal is to be indispensible to all geoscientists and our members' career partner for life.

Don't miss out. Make dues payments today on aapg.org.

MEMBERSHIP&CERTIFICATION

The following **candidates** have submitted applications for membership in the Association and, below, certification by the Division of Professional Affairs. This does not constitute election nor certification, but places the names before the membership at large.

Any information bearing on the qualifications of these candidates should be sent promptly to the Executive Committee, P.O. Box 979, Tulsa, Okla. 74101.

Information included here comes from the AAPG membership department.

(Names of sponsors are placed in parentheses. Reinstatements indicated do not require sponsors.)

Membership applications are available at www.aapg.org, or by contacting headquarters in Tulsa.

For Active Membership

Alabama
Chasse, Jacques, State Oil and Gas Board of Alabama, Tuscaloosa (J.H. Masingill III, B.L. Bearden, B.H. Tew Jr.)

Colorado
Rutty, Patrick, Aspect Energy, Littleton (M.L. Peffer, S.G. Schulz, C.W. O'Melveny)

Michigan
Barranco, Roswell Keith, Michigan Consolidated Gas/DTE Energy, Novi (reinstate)

North Carolina
Reid, Jeffrey C., North Carolina Geological Survey, Raleigh (R.D. Perkins, S.D. Heron Jr., K.M. Farrell)

Nebraska
Haley, Bruce W., Sparta Energy, Lincoln (R.L. Schumacher, M.P. Carlson, P.G. Martin)

New York
Palmerton, David L., The Palmerton Group, East Syracuse (B.R. Gill, A.M. Van Tyne, L. Collart)

Texas
Aryal, Niranjan, Schlumberger, Houston (W.A. Cantwell, C.L. Johnson, W.W. Xu); **Cutright, Bruce Lee**, University of Texas, Bureau of Economic Geology, Austin (E.C. Potter, S.W. Tinker, W.A. Ambrose); **Gulick, Sean Sandifer**, University of Texas at Austin, Austin (W.A. Ambrose, W.P. Mann, M. Sen); **Hasiuk, Franciszek J.**, ExxonMobil, Houston (K. Lohmann, L.J. Weber, J.A. Simo); **Reuber, Erin Sesslar**, Maersk Oil, Houston (C.D. Clerk, B.W. Horn, L.E. Duncan); **Simmang, Cody Michelle**, Core Laboratories, San Antonio (C. Keairns, R.B. Riess, B.E. Wawak); **Velasquez, Monique**, Chevron, Houston (D.B. Buthman, S.M. Patti, D.S. Beaty); **Wang, Jianwei**, Schlumberger, College Station (W.B. Ayers Jr., J.U. Abiazie, R.B. Martin)

Canada
Afolabi, Bunmi, Nexen, Calgary (J.R. Connick, D.A. Leckie, C.H. Idiagbor)

Kazakhstan
Fisher, George C., EPC Munai, Munai (F.H. Henk, K.M. Willis, J.J. Girgis)

Mexico
Juarez, Juan I., Pemex Exploration and Production, Villahermosa (F. Monroy-Santiago, J. Patino, V.M. Valois)

Nigeria
Akinwale, Sean Temitope O., Applied Energy Ltd., Lagos (A.R. Ojelabi, A.O. Esan, I.O. Ogun); **Briggs, Tamunoseleipiri**, Shell Petroleum Development Co. Nigeria, Port-Harcourt (I.T. Preye, G.O. Giwa, O.O. Falade); **Eshareghan, Ovokerhoyi Innocent**, Shell Petroleum Development Co. Nigeria, Warri (I.T. Preye, G.O. Giwa, O.O. Falade); **Feghabo, Inaingo**, Shell Petroleum Development Co. Nigeria, Port-Harcourt (I.T. Preye, G.O. Giwa, O.O. Falade); **Fresh, Ibifubira**, Shell Petroleum Development Co. Nigeria, Port-Harcourt (I.T. Preye, G.O. Giwa, O.O. Falade); **Koleoso, Kazeem Adewale**, Oando Exploration & Production Ltd., Lagos (O.A. Ojo, O.T. Odusote, B. Olaleye); **Onyehara, Iheanacho Theddeus**, Omel Energy, Lagos (M.L. Afe, E.G. Odior, A.O. Adesanya)

Peru
Allcca, Miguel Angel, Petrolifera Petroleum del Peru, Lima (M. Nicho-Pacheco, V.R. Sanz, J.C. Quinto)

Saudi Arabia
Waheed, Mohammed AbdulNauman, Saudi Aramco, Dhahran (M.O. Al-Amoudi, I.A. Al-Ghamdi, H.M. Al-Otaibi)

Certification

The following are **candidates** for certification by the Division of Professional Affairs.

Petroleum Geologist

Alaska
William A. Hunter, Chevron, Anchorage (B. Vorhees, D. Sturm, K. Pitts)

Texas
Michael P. Lewis, Discovery GeoServices Corporation, Forney (M. Pospisil, R. Findley, R. Larson)

West Virginia
Thomas H. Mroz, USDOE NETL, Morgantown (J. Lorenz, D. Morse, D. Billman)

Editor's note: Jeffrey Levine served on the now-sunsetted AAPG Committee on Global Climate Change as a representative of the Energy Minerals Division, co-chairing a series of scientific forums on climate change at national and international AAPG meetings. He is a geologist specializing in coal and unconventional gas resources, in Richardson, Texas.

Commentary

MWH – A Tool to be Used Properly

By JEFFREY R. LEVINE


LEVINE

"Hello. My name is Jeff, and I'm a skeptic."

That's how I might introduce myself if I were enrolled in a twelve-step program aimed at keeping my inveterate skepticism under control; but there is no such program, and I don't want to keep it under control anyway. Skepticism has served me well as a geologist, and I've had many exciting insights by doubting the accuracy and validity of various data or conclusions I've encountered – including my own!

During my three years serving on the now "sunsetted" AAPG Global Climate Change Committee I turned my skeptical eye toward the arguments and evidence both for and against the theory of "anthropogenic global warming" (AGW). I've weighed the available evidence, I've tried to assess its reliability, and I've reached my conclusions – for the time being, at least.

But my purpose here is not to discuss my conclusions, nor even to discuss the evidence. The AAPG leadership has wisely decided that climate change is not a subject we need to be debating publicly. Unfortunately, politicization of this issue has "poisoned the waters."

Rather, my goal is to discuss the pathway by which we reach our conclusions. I do so in the hope that over the course of time, this may contribute to a more rational discourse and a greater congruity of opinion. Convergence of opinion will happen eventually, by the way, as has already happened within the climate research community. This is the way of science. The only question is when. In this regard, sooner is better.

* * *

Scientists are continually trying to improve our understanding of the world around us. At any given moment, however, our understanding is flawed and incomplete. In some cases, even a broadly accepted "consensus" view ultimately proves to be in error.

Given this state of perpetual imperfection, how does one avoid the trap of clinging to established interpretations that may not be the best? T.C. Chamberlin's method of Multiple Working Hypotheses (MWH) can potentially provide a remedy, but only if it is properly applied.

Chamberlin, a geologist who served as president of the University of Wisconsin and subsequently as director of the Walker Museum at the University of Chicago, articulated his method in a series of papers and lectures during the 1890s.

Chamberlin's goal was to encourage creative thinking in scientific inquiry, particularly when working with complex, multivariate systems such as geology or climate, which may have complicated interactions and feedbacks. He recognized that it is easy to overlook some fundamental relationship or the important role of a previously unrecognized variable.

One of the principal goals of MWH is to avoid becoming mired in what Chamberlin termed the "ruling theory."

An influential professor of mine, Dr. Eugene Williams, taught us this method when I was a graduate student in geology at Penn State. Williams was almost obsessive in his commitment to MWH. When we were confronted with some puzzling set of observations, perhaps on a field trip or while conducting a lab exercise, he would insist that we come up with no fewer than seven hypotheses to explain what we were seeing. This forced us to think creatively – "outside the box."

Only after formulating seven hypotheses could we begin to pare down the list. We could reject hypotheses that were inconsistent with the evidence, or in conflict with established scientific laws. Alternatively, we could accept as "plausible" or "likely" any hypotheses that were supported by the evidence.

In some cases, additional data would be needed to further pare down the list; but if in the end, we were left with more than one possible explanation, this would be the best we could do.

* * *

Over the past few years, a number of my colleagues have cited the principle of Multiple Working Hypotheses as the basis for their skepticism regarding interpreted human impact on climate. They regard AGW – the consensus view of the scientific community – as the "ruling theory," and by virtue of their training, believe it essential to consider alternative hypotheses.

While I respect their intentions, however, and strongly endorse skepticism in the pursuit of scientific truth, MWH can serve as a useful tool only when it is applied properly. If applied improperly it may not merely yield invalid results, but can simultaneously engender a false sense of confidence that one has been rigorous and thorough in application of scientific reasoning, when in fact the opposite may be true.

There are several potential pitfalls that can be fatal to successful application of MWH. Prominent among these is that the method entails *two* essential components:

- Formulating as many alternative hypotheses as might be conceived.
- Testing and ranking these hypotheses according to the available evidence.

Some skeptics feel they've done their duty by applying the first step, while neglecting to rigorously apply the second. Such an exercise, however, will serve principally to increase confusion and doubt, particularly among those who are less familiar with the relevant data, while failing to accomplish Chamberlin's goal of avoiding dogma and improving understanding.

A significant underlying problem in the application of MWH is that the concept of the "ruling theory" is commonly misunderstood. Chamberlin did not necessarily intend this term to describe the predominant, or "consensus" view, although in many circumstances it *will*. Rather, "ruling theory" can describe any hypothesis that happens to be favored by an individual scientist.

In other words, Chamberlin was concerned about bias.

Chamberlin's meaning is made clear in the subtitle to his essay, which states, "With this method the dangers of parental affection for a favorite theory can be circumvented." The phrases "parental affection" and "favorite theory" imply parochial, proprietary bias toward a particular hypothesis.

Thus, to my understanding, Chamberlin's challenge to us as scientists is not

See **Commentary**, next page

Commentary
from prevous page

necessarily to doubt someone else's "ruling theory," but rather to doubt our own!

* * *

It is generally agreed that skepticism is an essential element of the scientific method.

A considerable risk confronting well-intentioned skeptics, however, is believing that they can demonstrate their open-mindedness, both to themselves and others, by daring to question the "status quo." Defying the norm, though, does not necessarily exempt one from the risks of "parental affection for a favorite theory." In fact, Chamberlin's entire approach is predicated on the assumption that the human mind is inclined toward bias and that, as scientists, we must struggle diligently to avoid it.

It is for this specific reason that MWH requires consideration of all possible interpretations of the data. Equally important, however, is that each alternative hypothesis must be assessed impartially.

I don't believe Chamberlin's intention was to be skeptical only of the ruling theory while applying a lesser degree of scrutiny to competing hypotheses, but rather to judge all hypotheses equally. Continuing to entertain hypotheses for which there is little or no supporting evidence renders MWH little more than a charade.

Unfortunately, the goal of avoiding bias can be very difficult to attain, no matter how lofty our intentions. In interpreting the drivers of contemporary climate change, we do not have the luxury of being able to design a "double blind" experiment, as in pharmaceutical testing, for example, and thus are forced to rely on our own integrity.

The history of geology has seen many successful applications of Chamberlin's method – one notable example being the debate during the 1960s and '70s over continental drift and plate tectonics. Many of our more senior members in AAPG lived (and fought!) through this dispute, and in many cases had to work patiently to acquire the evidence necessary to convince their skeptical colleagues that "horizontal plate motion" offered a superior explanation for observed geological phenomena than the ruling theory of "vertical tectonics."

Overcoming one's own ruling hypothesis can challenge the best of us, but all such issues are eventually resolved by further research and additional data.

* * *

Given that human nature has not changed appreciably since Chamberlin proposed his method, it can be safely assumed that climate scientists are no less susceptible today than they would have been 100 years ago to adhering to the "ruling theory." It is under such circumstances that valid skepticism becomes especially critical to reaching a valid conclusion.

Individual opinions may understandably differ on complex scientific questions such as climate change. It is not justified, however, to presume that someone who has reached a conclusion different from our own has simply failed to apply MWH – yet I've heard this argument made (or implied) by skeptical geologists in support of their own positions on climate change.

Ironically, the very presumption of guilt in failing to apply MWH itself represents a failure to apply MWH, as alternative hypotheses might be that: persons holding divergent views have access to more data, or have a deeper understanding of the relevant scientific principles, or have a broader background in the scientific literature, or – in some cases – are less susceptible to bias.

We may conclude through these examples that Chamberlin's method of Multiple Working Hypotheses can be a powerful tool in scientific inquiry, but like any tool (such as chainsaws, here in Texas where I live, for example) is subject to abuse if not used properly, and according to the manufacturer's guidelines.

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The Boone Pickens School of Geology at Oklahoma State University (OSU) seeks applications for two endowed chairs: the Chesapeake Energy Corporation Chair of Petroleum Geoscience and the Devon Energy Corporation Chair of Basin Research. We are particularly interested in candidates with interests in one or more of the following: unconventional energy resources, petrophysics, reservoir characterization/modeling, tectonics of sedimentary basins, depositional and diagenetic systems, and basinal fluids. These chairs will be filled at the level of Professor, will carry tenure in the School of Geology, and will be effective August 2011. Applicants must have a Ph.D. degree in geology or related field and have an outstanding record of research. The applicant must be committed to excellence in teaching both undergraduate and graduate students, will be expected to supervise M.S. and Ph.D. level graduate students and develop courses in her or his specialty.

The successful candidates will join a faculty of eleven geoscientists and will take leadership roles in a department that has close ties to the petroleum industry. The School's teaching and research facilities include state of the art geophysical field and laboratory equipment and software, the Devon Visualization Laboratory, and a wide range of petrographic and geochemical instrumentation. The School also has a recently renovated field camp facility near Canon City, Colorado.

Candidates should submit a letter of application, including a discussion of research interests and approach to teaching, along with a curriculum vitae and contact information for three references to: Endowed Chair Search, Boone Pickens School of Geology, 105 Noble Research Center, Oklahoma State University, Stillwater, Oklahoma 74078-3031. Screening of candidates will begin on November 8, 2010 and continue until the position is filled. More information about the Boone Pickens School of Geology can be found on the web http://geology.okstate.edu along with additional information about these opportunities. Inquiries may be directed to Dr. Todd Halihan (todd.halihan at okstate.edu) or Dr. Jay Gregg (jay.gregg at okstate.edu). Committed to health and safety Oklahoma State University maintains a tobacco free work environment. Oklahoma State University is an Affirmative Action/Equal Opportunity/E-Verify employer committed to diversity.

* *

Field Station Executive Director, Geological Sciences, Indiana University, Bloomington

The Department of Geological Sciences at Indiana University, Bloomington, invites applications for a senior administrative appointment to advance the initiatives for developing programs and infrastructure envisaged in the strategic plan for the IU Geologic Field Station in Montana.

We seek an individual of renowned repute in industry and/or academia who can implement a business plan for the Field Station that will support and sustain significant curriculum expansion and infrastructure enhancement. Critical qualities for this position include the ability to reinforce existing links with industry and alumni and to co-ordinate all activities associated with the Field Station.

Applicants should hold a degree in geosciences, possess extensive managerial skills and industrial experience, and a proven record of teaching geology in the field. Familiarity with the IU Geologic Field Station program and its setting is strongly preferred. The responsibilities and terms of the position, initially funded as a half-time appointment, are negotiable and will be based on qualifications. Residency at the Field Station is required during the summer and in Bloomington during part of the academic year.

Enquiries should be addressed to Simon Brassell,

Continued on next page

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Professor and Chair, Department of Geological Sciences, Indiana University, Bloomington, IN 47405-1403, geochair@indiana.edu. Applications must be submitted on-line at https://jobs.iu.edu/ (#2015).

Indiana University is an equal opportunity/ affirmative action employer, and encourages applications from women and minority candidates.

* *

SEDIMENTARY GEOLOGY
UNIVERSITY OF WYOMING

The Department of Geology and Geophysics (http://geology.uwyo.edu) invites applications for a tenure-track, Assistant Professor position in sedimentation/stratigraphy. Ph. D. is required at the time of appointment. We seek an individual who shows the potential to develop an internationally recognized, externally funded research program, will be involved in the undergraduate and graduate teaching mission of the department, and will complement departmental strengths. Specialty is open and may include such diverse fields as petroleum geology, quantitative basin analysis, seismic stratigraphy, carbonate sedimentation, paleoclimate reconstruction, and physical sedimentology. Relevant instrumentation in the Department includes: fission-track laboratory, multi-sensor core logger, micro-analytical facility, high-abundance sensitivity TIMS, LA-ICPMS, a next generation multi-collector ICPMS and a modern reflection seismology lab. The University includes the School of Energy Research (http://www.uwyo.edu/ser/) and a centralized Stable Isotope Facility (http://uwacadweb.uwyo.edu/SIF/).

Applications should include a statement of research and teaching interests and accomplishments, curriculum vita, and the names and contact information of three references. Review of completed applications will begin November 15, 2010. Send a compiled electronic copy (PDF version preferred) of your application to the search committee (sedsearch@uwyo.edu). If you have additional application materials to send, please direct them to Sedimentary Search Committee, Dept. 3006, Geology & Geophysics, University of Wyoming, 1000 E. University Ave., Laramie, WY 82071.

The University of Wyoming is an equal opportunity-affirmative action employer.

* *

Project Director, University of Texas Gulf Basin Depositional Synthesis Project

The Gulf Basin Depositional Synthesis (GBDS) is an industry sponsored consortium operated by the University of Texas at Austin, Institute for Geophysics (UTIG) with a 15-year record of developing and providing consortium members a detailed, comprehensive, and integrated synthesis of the Cenozoic history of the entire Gulf basin. The new GBDS director will direct the existing program and will spearhead development of new research initiatives. This is a senior-level position requiring a PhD degree with 10 or more years of industrial experience in petroleum exploration with emphasis on regional studies, reservoir sedimentology of clastics and/or carbonates, petroleum systems, and GIS database applications.

Please refer to posting number 10-08-18-01-0371 for a full description and requirements of the position and for instructions on how to apply at http://utdirect.utexas.edu/pnjobs/index.WBX. The University of Texas at Austin is an EEO/affirmative action employer. All positions are security sensitive, and conviction verification is conducted on applicants selected.

* *

Petroleum Exploration Geologist
Newfield Exploration
Tulsa, OK

Seeking Geologist, responsible for conducting detailed prospect analysis and play fairway assessments within the Mid-Continent Region plus the generation and presentation of prospect ideas and leads to management. This position would be located in Tulsa, OK.

The successful applicant will generate and update maps, logs, cross-sections and corporate databases with new tops, correlations, shows and other pertinent geological data. Develop regional, multi-county stratigraphic framework and subsurface correlations.

Minimum qualifications, ten years of experience, knowledge of Mid-Continent upstream oil and gas, experience with conventional and un-conventional plays, experience doing play-fairway analysis assessments. Send resume to klefler@newfield.com.

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Chevron

Chevron Exploration Geologist – Seal and Trap Specialist

Chevron Energy Technology Company, a subsidiary of Chevron U.S.A., is accepting online applications for a high-caliber, experienced Exploration Geologist – Seal and Trap Specialist located in Houston, Texas with proven leadership skills. The Seal and Trap Team provides exploration scale predictive reservoir stratigraphy and seals/shales stratigraphy. The job scope could expand to include development and production reservoir compartmentalization issues.

Responsibilities:

- Develop and apply Integrated Seal and Trap analysis techniques with a focus on the structural aspects of exploration-scale seal and trap issues to assess risk and uncertainty.
- Extensive collaboration across Chevron as the subject matter expert, as well as mentoring, consortia stewardship and course development/training.

Requirements:

- Master's Degree in Geology or related discipline.
- A minimum of three (3) years directly related experience.
- Ability to evaluate and design new technology solutions.
- Skilled in evaluating trap integrity and geologic risk.
- Knowledge of fault or top seal analysis.
- Strong background in basin analysis, ability to integrate and QC diverse datasets.
- Ability to work individually and collaboratively with the technical and operations teams.
- Skilled in seismic interpretation, framework validation, and/or earth modeling (Gocad or Petrel).
- Ability and willingness to learn new software related to trap and seal analysis.

To learn more about this exciting position and to apply visit www.chevron.apply2jobs.com and search by functional discipline Earth Science or by requisition number 032214645.

All applicants must apply via the Chevron online application process.

EOE M/F/D/V

المعهد البترولي
THE PETROLEUM INSTITUTE
Abu Dhabi, UAE

FACULTY POSITIONS
Petroleum Geosciences

Petroleum Geosciences Department
is seeking applications for the following positions:

Chair Professor, Distinguished Professor
Professor, Associate Professor, Assistant Professor
Senior Research/Teaching Associate
Research/Teaching Associate

Department faculty will be expected to teach undergraduate and graduate courses, develop an active research program, and to engage in professional and institutional service activities. Opportunities to interact with PI industrial stakeholders and other local industries will be a key feature in the development of a research program.

Institution: The Petroleum Institute (PI) was created in 2001 with the goal of establishing itself as a world-class institution in engineering education and research in areas of significance to the oil and gas and the broader energy industries. The PI's sponsors and affiliates include Abu Dhabi National Oil Company and several major international oil companies, namely Shell, BP, Jodco and Total. The campus has modern instructional laboratories and classroom facilities and is now in the planning phase of three major research centers on its campus. The PI is affiliated with the Colorado School of Mines, the University of Maryland (College Park), the University of Minnesota and Johannes Kepler University in Linz, Austria. Recent additions to collaborating institutions include Rice University and University of Texas, Austin. The growth of the PI is instrumental to meet the business and research needs of the fast growth of the UAE industry. For additional information, please refer to the PI website: **www.pi.ac.ae.**

For details on the positions and to submit your application, please go to:
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Review of applications will begin immediately
and will continue until successful candidates are selected.
Only shortlisted applicants will be notified.

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DIRECTOR'S CORNER

On the Cusp of Beginning a New Era

By RICK FRITZ, AAPG Executive Director

"Beginning" is one of the most important words in our vocabulary. Great philosophers and thinkers have expounded on "beginning."

Plato said, "The beginning is the most important part of the work."

Horace said, "Once begun, a task is easy." (I'm not sure I agree with that one!)

Cicero said. "Before beginning, prepare carefully!"

Longfellow said, "Great is the art of beginning, but greater is the art of ending."

Even though I have worked for AAPG for 11 years I feel like AAPG is at the edge of a "beginning." This theme was established by President Dave Rensink when he asked the leadership to consider this year as a new beginning and contemplate the future for the Association.

To that end the Advisory Council is in the process of reviewing the AAPG Strategic Plan.

At the AAPG Leadership Days in August, the major theme was, "What would AAPG look like in 2035?"

The demographics of AAPG would be significantly different. Most likely AAPG will have more members living outside of North America than within. Many of the baby boomers will be retired and the current students and young professionals will be in leadership positions in their companies and professional associations.

In 2035 there will be tremendous advances in science and technology compared to the present. New resource plays will be developed and new technology will allow the re-development of old fields.


FRITZ

Even though I have worked for AAPG for 11 years I feel like AAPG is at the edge of a "beginning."

Communications will change significantly. Watches, cell phones and laptops will be obsolete, and we will disseminate scientific information in ways we've never dreamed.

* * *

In September I attended the International Conference and Exhibition in Calgary, Canada. The overarching theme of the meeting was forward looking at unconventional reservoirs and unconventional thinking.

One of my favorite sessions was the management forum titled "E&P Challenges in Complex Environments: From the Arctic to Deep Water." It featured keynote speaker Amin Nasser, senior vice president-E&P for Saudi Aramco. The session co-chairs were Pinar Yilmaz, of ExxonMobil, and Sa'id A. Al-Hajri, of Saudi Aramco.

The panel in this session comprised:

- **Jose Luiz Roque**, E&P executive manager drilling, Petrobras.
- **David Lawrence**, executive vice president-exploration and commercial, Shell.
- **Robert "Bobby" Ryan**, vice president of global exploration, Chevron.
- **Tony Doré**, global exploration vice president-North America, Statoil.
- **Rod Nelson**, vice president-Communications, Schlumberger.

They discussed the challenges and opportunities of future projects and how the industry will face increasing technical difficulties and financial risks. Many of the plays have been known to the industry for some time, but commodity prices were too low for exploration and development.

Of course, unconventional reservoirs were an important part of this discussion. Oil and gas shales around the world are now in play, and although we now have the technology for development there are still many obstacles, such as land issues and political policies.

One of the most interesting "new beginnings" discussed was Arctic exploration. This new frontier presents unique challenges and tremendous opportunities. We are now at the threshold of development of this vast area as blocks have been taken and exploratory wells planned for the near future.

AAPG is very involved in the science of the Arctic with its Polar Petroleum Potential conference scheduled for Halifax, Nova Scotia, Canada, late next summer. AAPG also operates the Arctic Technology Conference for the Offshore Technology Conference, to be held Feb. 7-9 in Houston.

* * *

One of my favorite quotes on "beginning" is from Thomas Edison, the great applied scientist and inventor, who once said, "I start where the last man left off."

It is an understatement to say that there will be a lot of changes in our industry and profession in the next 25 years. AAPG is now at a critical stage of its development, and it is important to take steps to prepare for the changes observed by the Association and industry leadership.

DIVISIONS' REPORT

DPA: Ethics and Professionalism

By DANIEL J. TEARPOCK, DPA President

How time flies when one is having fun! I am into the first three months of my DPA presidency and things are really hopping.

Being president gave me reason to cogitate upon ethics and professionalism as it pertains to geoscientists.

As geoscientists, we all know the vital importance of possessing sound technical skills and knowledge in our area(s) of specialty. But how often do we consider how ethics and professionalism play important roles in our daily work and overall careers?

Steve Sonnenberg said it well in the DPA publication "Guiding Your Career As A Professional Geologist," when he stated:

"Honesty is fairness and straightforwardness of conduct. It is adherence to the facts. It is the refusal to lie, steal or deceive."

Ben Franklin was quoted as saying: "A lie stands on one leg, the truth on two."

Professionalism, honesty and ethics equal integrity. When we combine integrity and competence, they form the cornerstones of a geoscientist's successful career.

AAPG has a Code of Ethics. Its general principles are:

- Geology is a profession and the privilege of professional practice requires professional morality and professional responsibility.
- Honesty, integrity, loyalty, fidelity to trust and inviolability of confidence are incumbent upon every member as professional obligations.
- Each member shall be guided by high standards of business ethics, personal honor and professional conduct.


TEARPOCK

All AAPG members should take time to reflect not only on your technical skills and abilities but also on your ethics and professionalism. A good reputation can take years to build, but only one second to destroy.

* * *

As I mentioned in my last article (July EXPLORER), the DPA is expanding our mission of ethics and professionalism to the AAPG global Regions. To date, we have approved the DPA Bylaws change to establish a councilor for each AAPG global Region. With the assistance of the Regions presidents – David Dolph (Canadian Region), David Cook (European Region) and Joe Lambiase (Asia-Pacific Region) – we already have three outstanding international Regions councilors. They are:

- **Bill Haskett**, Canadian Region.
- **John Brooks**, European Region.
- **Bob Shoup**, Asia-Pacific Region.

We are excited about our first three Regions councilors and are confident that they will do a great job within their Regions to spread the DPA's mission of Ethics and Professionalism, as well as build our membership within these regions.

* * *

In July, I participated in the Regions presidents' teleconference call at the initiation of Carol McGowen, the AAPG manager for Regions and Sections. This call gave me the opportunity to discuss DPA's plans for international expansion.

The teleconference call already has resulted in two new, confirmed DPA international activities:

- I have been invited to present a talk to the Dhahran Geoscience Society in Saudi Arabia in late October on the DPA, its function within the AAPG and our planned global expansion.

And we can't forget the AAPG's ICE held in Calgary last month. The DPA sponsored a very successful Wednesday luncheon with nearly 180 people in attendance. David C. Elliott presented a talk entitled, "Evaluation and Classification Issues of Unconventional Resources." Elliott is the Chief Petroleum Advisor for the Alberta Securities Commission.

* * *

Domestically:

- DPA participated in September at the Eastern Section's annual meeting in two ways – I gave the All-Division Luncheon talk, titled "The Division of Professional Affairs (DPA): Professionalism as it Applies to Petroleum Geoscience," and we sponsored a short course on "The Quality Control of Subsurface Maps."
- The GEO-DC once again hosted its Geosciences Congressional Visits Day in Washington, D.C., in September.

Led by David Curtiss, GEO-DC director, and Deborah Sacrey, DPA Governmental Affairs Committee chair, the AAPG/DPA goes to Washington twice per year to meet with lawmakers and their staffs to answer questions and offer geological insight and expertise.

Energy is back on the radar screen in Washington – the Senate is considering both energy and climate change legislation.

- At the upcoming GCAGS annual meeting (Oct.10-12) in San Antonio, the DPA is a sponsor of two short courses: Ethics for Lunch, offered on Monday, and Ethics for Breakfast on Tuesday morning.

These two courses are taught by J. Cary Barton of Barton, East & Caldwell.

To further excite geoscientists to join their colleagues at the GCAGS, Oktoberfest is being held on Friday and Saturday, Oct. 8-9. What good geologist can turn down a beer at Oktoberfest, especially while sitting on the Riverwalk in San Antonio? For sure, I will be there!

* * *

One final note: THINK VOLUNTEERISM!

The AAPG and DPA work hard to provide value to its members in many ways. However, we cannot accomplish our goals without the assistance of YOU, our members.

Please consider volunteering on a committee, running for office, chairing a conference or participating in some way to assist your society.

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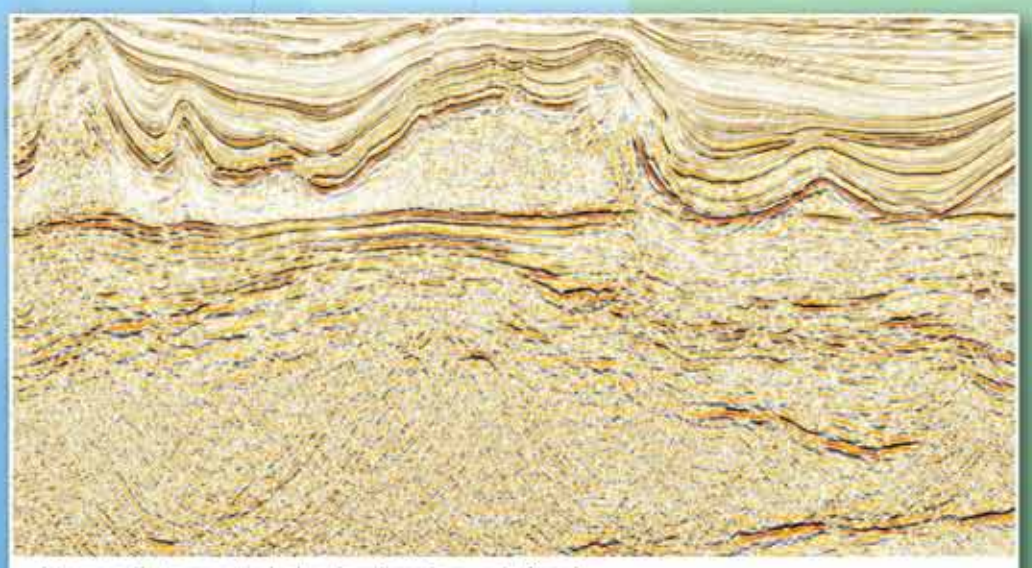

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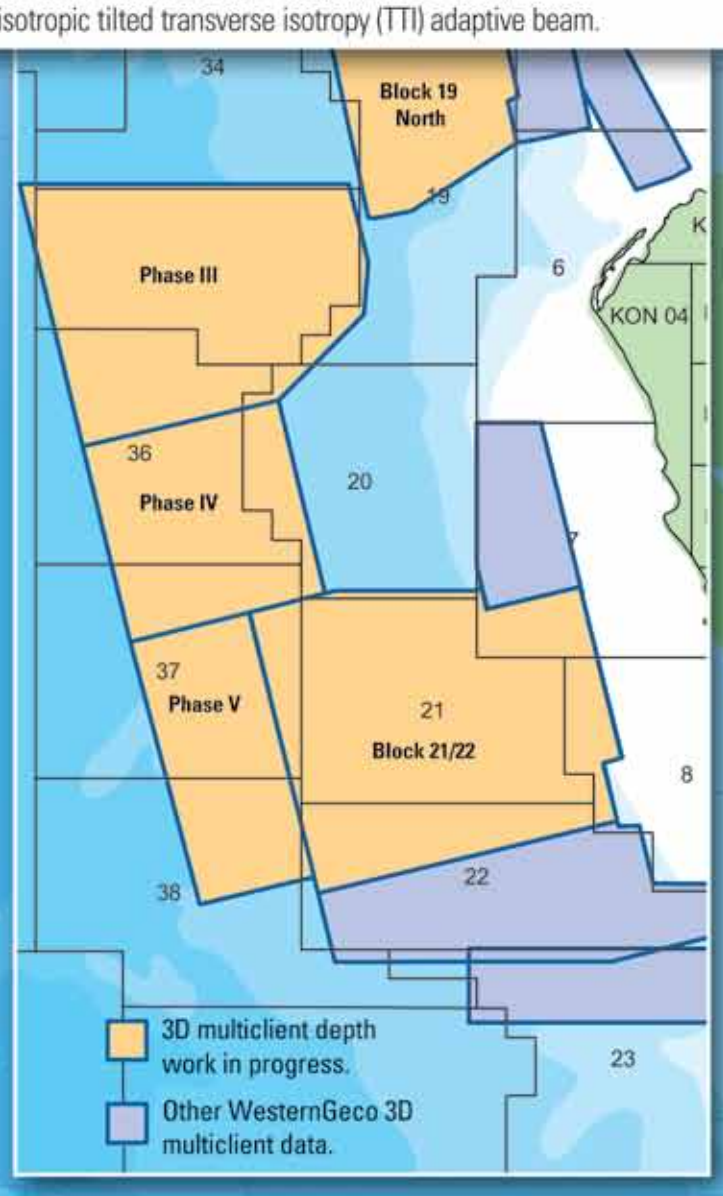

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A huge reprocessing project in the Kwanza basin focusing on presalt imaging is underway. Highlights from this multiclient project include:

- 25,000 km^2 of 3D anisotropic TTI prestack depth migration
- 3D GSMP* general surface multiple prediction technology
- Petrel*-ready deliverables.

Final products will be available in phases from Q3 2010.

For more information call +44 (0)1293 556533.

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