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Explorers warm to Mediterranean waters

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Greenfield/ Brownfield technologies

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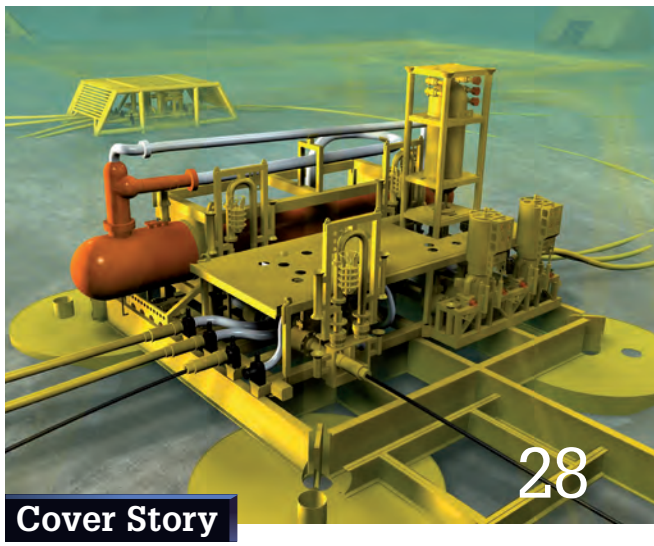

Cover Story

The recovery challenge

Increased oil recovery techniques serve as enhancers for maximizing production from brownfields and enablers to improve the economic viability of greenfield developments. Chris Shaw of FMC Technologies examines the issues.

ON THE COVER

The *Ensco 5006* semisubmersible continues to drill for Noble Energy, testing structures in the Levant Basin. Multiple gas discoveries have been made since 2009, revealing a total discovered reserve base of 35.6tcf to date. Credit: Ensco plc.

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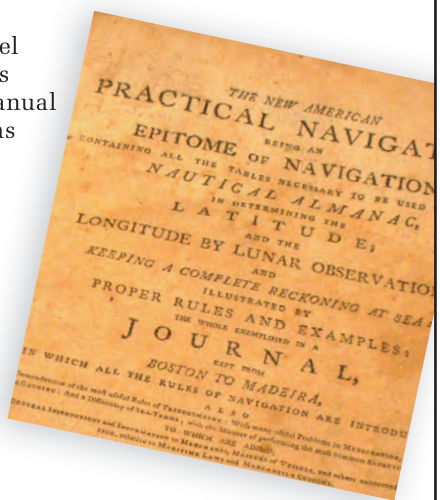
LET'S WORK.

Volume 38 Number 3

Departments & Columns



COLLECTOR'S EDITION

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Offshore Tunisia heats up

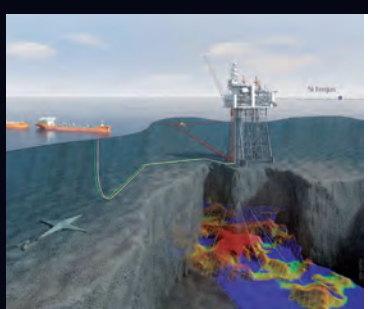
OE reports on new activities and financing along the North African country's shoreline.

Online Exclusive

People

Weiss to lead BP Alaska

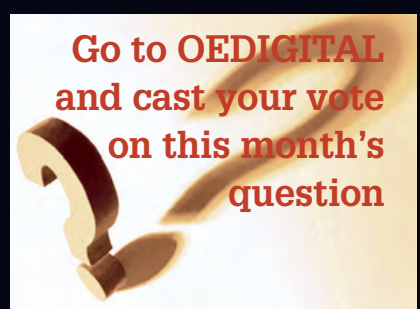
Janet Weiss replaces John Minge, whom now heads BP America.



What's trending

Rising investment – and costs – in UK North Sea

Investment in UK North Sea oil and gas production has been predicted to top a 30-year high – but cost per barrel has risen five-fold in the past decade.



Go to OEDIGITAL and cast your vote on this month's question

Eni adds to Mozambique finds

Eni's Coral 3 well adds 4tcf to its Mamba Complex in Area 4.

BP makes KG D6 commitment

BP and Reliance Industries Ltd. announce plans to invest US$5 billion on its KG D6 development off India.

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INCEPTION

THE BEGINNING OF AN IDEA

LEFT TO RIGHT
Jim McAllister (Oceaneering), **Bob Curtis** (Fugro), **Doug Bolingbroke** (Apache), **Barney Paternostro** (LLOG), **David Brown** (Tetra), **Colin Johnston** (Helix), **Ray Stawaisz** (Chevron)

The best ideas come from a collaborative process

Collaboration is a critical component of any process, whether you are strategizing, solving complex business problems, or developing new customer solutions. Shown here, members of the Deepwater Intervention Forum's board are collaborating on the curriculum for the 2013 Forum – "Sharing Technology, Bridging Resource Gaps, and Improving Competencies in a Growing Market." The success of this important industry event is a direct result of the ongoing collaboration by these subject-matter experts.

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All proceeds generated from this event benefit the Society of Professional Women in Petroleum's Scholarship Fund, which has awarded over $820,000 to young women since 1982.

Voices

Taking the reins.
US Department of the Interior Secretary Ken Salazar will resign his position at the end of this month, after four years in the Obama White House. With the nomination of REI chief Sally Jewell last month, *OE* asked: "On what key offshore issue should the incoming secretary focus in 2013?".

Secretary Jewell will inherit an offshore US oil and gas leasing plan that is not new. It restricts the oil and natural gas industry to the same areas of exploration that we've been searching for decades. In 2008, moratoria were lifted and the door opened to exploration for 85% of offshore areas. Instead of crossing the threshold into American energy security, the current five-year plan shuts the door on billions of barrels of oil, trillions of cubic feet of gas, billions in additional federal revenue, and tens of thousands of new jobs. Secretary Jewell should **immediately initiate a truly new five-year plan** and uphold the President's pledge to streamline the permitting process.

Randall Luthi, president, National Ocean Industries Association

Go to WWW.OEDIGITAL.COM and give us your opinion on what the key offshore issue is.

The Department of the Interior is key to the future of American energy policy. President Obama campaigned on implementing a true 'all of the above' energy plan for America. This opportunity could create millions of new jobs here at home and generate hundreds of billions of dollars for the federal government at a time we need it most. However, 87% of the offshore areas controlled by the federal government are still off-limits to oil and natural gas development. **Increasing access to America's vast energy resources should be a top priority** for the next Interior Secretary.

Jack Gerard, president and CEO of the American Petroleum Institute

Given the disastrous attempt to drill exploration wells in the Arctic Ocean in 2012, the new Secretary should suspend all activities on Arctic Ocean leases and undertake a thorough, independent assessment of what went wrong and how decisions were made to allow such risky activity. The Secretary should **focus on comprehensive planning for the Arctic** that includes identifying important ecological areas, demonstrating response capability, and fairly balancing risks and benefits.

Susan Murray, deputy vice president, Pacific, Oceana

I would point to the Secretary of Interior's need to **focus on the Arctic.** It isn't the highest near-term potential energy source, but it has significant long-term potential and will have implications for energy production and environmental protection across international borders. It is a key issue now, given the setbacks in Shell's drilling and the strict licensing regime.

Neil Robert Brown, staff member, US Senate Foreign Relations Committee

As an industry we have a fundamental responsibility to manage our business in a safe and environmentally conscious manner. I would challenge the Department of the Interior to **look at processes that drive efficiencies** while satisfying the need to ensure that proper engineering design, compliance, and due diligence is being conducted. Their focus needs to go beyond permitting and cover efficiencies across the entire well delivery process. (*See 'On the Move', page 77, for more on Dan Gualtieri.*)

Dan Gualtieri, vice president of Production Solutions, Knowledge Reservoir

OE

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Colloquy

Nina M Rach

The epitome of navigation

Accurate and safe marine navigation – monitoring and controlling the movement of a craft from one place to another – is often taken for granted in our industry. Navigational techniques involve locating the navigator's position compared to known locations, critical for safe passage, precise surveys, and exact placement of subsea structures.

Earliest records of navigation as a science come from the Indus Valley civilization, along the Indus River, which flows from the Tibetan Plateau through India and Pakistan. Among the earliest navigation tools are the mariner's astrolabe (possibly in use as early as 1295), reflecting quadrant, octant, and sextant, and the medieval Portolan charts, navigational maps based on compass directions and estimates of observed distances.

Modern navigation relies primarily on satellite positioning, or on crossing lines of position (LOP) identified on a nautical chart and by direct observation. LOPs include compass bearings, transits, leading lines, and can also be determined from leading and sector lights. The intersection of two LOPs is a single 'fix,' used to determine location.

Sadly, basic marine navigation skills fall outside most ordinary curricula. Mariner scouting programs began to train youth in England and moved to the US shortly thereafter; Sea Scouting in America was founded in 1912, and the Mariner Girl Scout program officially began in 1934. The Sea Scouts organization has been co-ed since 1971.

Maritime academies

The Royal Observatory at Greenwich was founded in 1675, and in 1767, began to publish *The Nautical Almanac and Astronomical Ephemeris*. It was the first almanac containing data for the convenient determination of longitude at sea. Since 1958, Her Majesty's Nautical Almanac Office

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OE (Offshore Engineer) is published monthly by AtComedia LLC, a company wholly owned by IEI, Houston. AtComedia also publishes **Asian Oil & Gas**, the **Gulf Coast Oil Directory**, the **Houston/Texas Oil Directory** and the web-based industry sources OilOnline.com and **OEDigital.com**

US POSTAL INFORMATION
Offshore Engineer (USPS 017-058) (ISSN 0305-876X) is published monthly by AtComedia LLC, 1635 W. Alabama, Houston, TX 77006-4196.
Periodicals postage paid at Houston, TX and additional offices.
Postmaster: send address changes to Offshore Engineer, AtComedia, PO Box 47162, Minneapolis, MN 55447-0162

and the US Naval Observatory have jointly published a unified *Nautical Almanac*.

Training in advanced navigation is relegated to nautical study programs for merchant shipping and defensive navies, such as Britain's Royal Naval College. Napoleon Bonaparte founded a maritime academy in Antwerp in 1814, which was 're-founded' under the Belgian regime in 1834. The National Maritime College of Ireland (NMCI) is among the most recent; it opened to students in 2004 and offers Marine Engineering and Nautical Science degree courses.

SUNY Maritime College, Fort Schuyler, Bronx, New York was the first US college of its kind (federally approved, offering commercial nautical instruction), founded in 1874. There are only a handful of accredited maritime colleges in the country, including the US Naval Academy (Annapolis, MD), US Coast Guard Academy (New London, CT), US Merchant Marine Academy (Kings Point, NY), California Maritime Academy (part of the California State University system, Vallejo), Great Lakes Maritime Academy (a division of Northwestern Michigan College), Maine Maritime Academy (Castine), Massachusetts Maritime Academy (Buzzards Bay), Texas Maritime Academy (part of the Texas A&M University System, Galveston), and the private Maritime Institute Inc. (San Diego, CA).

Bowditch

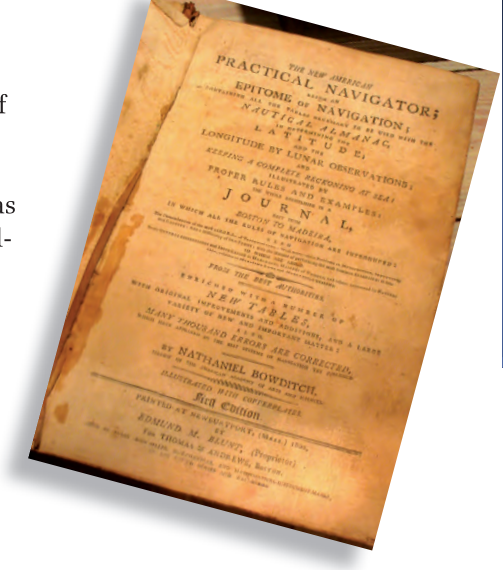
It's difficult to consider the life and accomplishments of Nathaniel Bowditch without a certain degree of awe. Born on 26 March 1773 – 240 years ago this month – he was inquisitive, gifted, and motivated to learn. He left school at age 10 to work in his family's cooperage business in the port town of Salem, Massachusetts. He was employed at 12 as a bookkeeping apprentice to Ropes & Hodges, ship chandlers, working on the day-to-day financial transactions of supplies and equipment for ships. In the evenings, he studied in the library of Jonathan Hodges, and was encouraged by three local, Harvard-trained scholars. Over the course of his nine-year indenture, he read math, science, astronomy, and languages, learning algebra at 14, calculus at 16, Latin at 17, French at 19.

Bowditch built his own astronomical and surveying instruments and participated in a land survey of Salem in 1794. His accuracy and thoroughness resulted in an invitation from shipmaster John Gibaut to clerk on his first sea voyage in 1795. Bowditch studied sea journals and navigation techniques, and made five trips to the East Indies, from 1795 to 1803. While at sea he studied charts, took lunar measurements, and recorded his observations. Bowditch was also interested in the mathematics behind celestial navigation and his mastery of French later enabled him (beginning in 1812) to translate the five volumes of French mathematician and astronomer Pierre Laplace's *Traité de Méchanique Celeste* into English: *Treatise on Celestial Mechanics*.

His practical sailing experience and astronomy scholarship made him one of the best navigators in America and secured his place in history. In the late 18th century, mariners relied on navigation tables prepared by John Hamilton Moore of the British Royal Navy, and others. Edmund March Blunt commissioned Bowditch to update and revise *The American Coast Pilot*, published in 1796, and Bowditch checked the data and recalculated the tables 1797-98.

Bowditch was elected to membership in the American Academy of Arts & Sciences in 1799, and was awarded an honorary LLD from Harvard College in 1802.

In the same year, Bowditch published *The New American Practical Navigator*, a completely new, comprehensive work that



explained the principles of navigation, surveying directions, winds, currents, directions on how to calculate high tides, a dictionary of sea terms, an explanation of rigging, keeping a ship's journal or log, and business topics such as contracts, insurance, and bills of exchange. It became known as 'the seaman's bible' and went through 10 editions before Bowditch died in 1838. His son, J Ingersoll Bowditch, took over editorial responsibility for editions published over the following 30 years.

In June 1866, the United States Hydrographic Office was established as part of the Bureau of Navigation, Department of the Navy, and it purchased the copyright and plates for $25,000 from George Blunt (son of publisher Edmund M. Blunt).

The US government has published 52 editions since acquiring the copyright, the most recent being the 2002 bicentennial edition. The US National Geospatial-Intelligence Agency offers free digital files of *The American Practical Navigator*. The entire document or separate chapters and tables can be downloaded. Although online editions of Bowditch are constantly updated, a hardcover edition never crashes or has to be rebooted, and is never subject to the vagaries of battery failure.

Such is the appreciation of this time-tested volume that it has its own Facebook page: Bowditch's American Practical Navigator. OE

ThoughtStream

Paolo Scaroni, Eni SpA

Eni renews MIT partnership

Eni recently renewed its energy research partnership with the Massachusetts Institute of Technology Energy Initiative (MITEI), establishing a new path forward for this highly successful collaboration. This alliance provides an opportunity to bring together Eni's technology assets with MIT's excellence in scientific and technological research. Our goal is to develop innovative, powerful tools, technologies, and solutions to address global energy needs and challenges.

Eni is a MITEI founding member, a key partner since shortly after MITEI's launch and is also MITEI's largest energy research sponsor. Eni's funding significantly exceeds the founding member support level of US$5 million/year, advancing research projects that span the energy spectrum from traditional hydrocarbons to methane hydrates to solar energy.

Over the past five years we have had a number of great successes:

- Solar power has been a key focus of the partnership through the Eni-MIT Solar Frontiers Center, and perhaps the most interesting innovation has been the technology to print solar cells on paper, making them flexible, durable and cheap.
- The research effort has also focused on our traditional oil and gas activities. For instance, we have developed a new integrated modeling system which allows us to better understand and develop hydrocarbon reservoir. And very importantly in a post-Macondo world, we have been working on a system to clean-up oil spills more efficiently using super-absorbent materials.

The Eni E&P division is interested in exploring new research techniques for sustainable exploitation of conventional and unconventional hydrocarbon sources, starting with novel approaches and studies for improving subsurface description and reservoir simulation. The alliance will also extend to the Eni G&P division, with a focus on natural gas utilization with distributed generation, energy storage, and renewables.

> MIT brings the best of academia and a vocation to broad-spectrum innovation, while Eni brings 50 years of technical experience and a pragmatic focus.

As well as generating interesting technological innovations, the Eni-MIT partnership has another great success to its name. We have developed a unique way of working together. MIT brings to the table the best of academia, and a vocation to broad-spectrum innovation, while Eni brings 50 years of technical experience and a pragmatic focus on industrial viability. The result is a partnership that generates real innovations of real economic significance.

The way in which we work and what we have achieved so far means that we have great hopes for the next four years together. The focus will be on generating new ideas to improve the efficiency and sustainability of the oil & gas industry and on maturing some of the most important discoveries made to date.

- Key areas of interest will cover all aspects of our business – from reservoir modeling and natural gas distribution and storage to 'green chemicals' – by which we mean chemicals made out of biological matter instead of fossil fuels.
- At the same time, solar power will continue to be a pillar of our collaboration – we are intending to run pilot projects to develop flexible solar cells and build a prototype of a solar concentrator for steam generation.

We have a very exciting time ahead of us. And on the back of a successful five-year track record, I have every confidence that the Eni-MIT partnership will contribute to solving the energy challenges of today – and of tomorrow. OE

Paolo Scaroni *has been CEO of Eni since June 2005. He graduated in economics from the Università Luigi Bocconi, Milan, and later earned an MBA from Columbia University, New York. In November 2007, he was decorated as an Officier of the Légion d'honneur.*

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Global Briefs

A Gulf of Mexico lease sale

The US Bureau of Ocean Energy Management and US Department of the Interior announced that Central Gulf of Mexico Lease Sale 227 will offer 28.6 million acres off Louisiana, Mississippi, and Alabama. The sale will take place this month in New Orleans. The sale comprises 7299 blocks located approximately 4km to 370km offshore in water depths ranging from 3m to 3400m.

B New Irish play

A full tensor gradiometry and magnetic airborne survey revealed a new oil prospect off the coast of Northern Ireland for Providence Resources. The Polaris prospect, located in the Rathlin Sound, lays structurally on-trend with the onshore 2008 Ballinlea-1 well. Gravity data indicates the Polaris structure covers 30 sq km area with an in-place prospective resource potential of 530 million barrels of oil. Given its near-onshore location, Providence may pursue an onshore well.

C Wintershall wildcat's a gas

Wintershall Norge hit gas and condensate at its Norwegian Sea wildcat 6407/1-6 S. The well discovered water-bearing reservoirs with gross vertical thickness of 118 and 123m, respectively, in the Garn and Ile formations. Gas and condensate were found in three sandstone intervals with a 9m thickness in the Lange formation. The Transocean Arctic drilled the wildcat to a vertical depth of 4,050m. It will be plugged and abandoned.

D Nefertiti approved

The Egyptian government approved Dana Petroleum's development plan for the Nefertiti oil field in the Gulf of Suez following a successful appraisal at the Nefertiti-2X well. Dana says the field is the first it developed by drilling extended reach wells from an onshore location. Dana and partner Inpex expect the Nefertiti-2X well to produce 2500b/d when the field comes onstream this summer.

E Mafumeira Sul advances

Chevron subsidiary Cabinda Gulf Oil will proceed with the second stage development of the Mafumeira Sul project located in block 0, 24km off Cabinda, Angola in 60m of water. Scope of the US$5.6 billion project includes 50 wells, two wellhead platforms, a central processing and compression facility, and 121km of subsea pipelines.

L Sapinhoá startup

Commercial production began at Sapinhoá field in January. Located in block BM-S-9 in Brazil's pre-salt region, the first producing well, Guara-1, was connected to the FPSO *Cidade de São Paulo*. Guara-1 has a potential production rate of 25,000b/d. With more wells to be connected to the FPSO, a production rate of 120,000b/d could be achieved by 1H 2014.

M Cyprus entry

A consortium made up of Eni and Kogas has won three deepwater blocks during the Republic of Cyprus's second offshore licensing round. The consortium walked away with blocks 2, 3, and 9 in the Cypriot deepwater portion of the Levantine Basin, which spans 15,530 sq km. Eni will operate the blocks with 80% interest; Kogas holds the remaining 20%. This is Eni's first foray into Cyprus.

N Valhall in production

Production has begun at BP's Valhall redevelopment project in the Norwegian North Sea. The project aims to increase Valhall's life span by an additional 40 years. Current capacity is set at 120,000b/d of oil and 143mmcf/d of gas. BP expects production to increase to 65,000boe/d by 2H 2013.

O Tamar jacket delivery

Rotterdam-based transporter Fairmount Marine delivered Noble's Tamar jacket to the eastern Mediterranean last month. The 18,500-ton jacket was built in Corpus Christi, Texas, and traveled 9000 miles from the US on Heerema Marine Contractor's *H-851* barge towed by Fairmount Marine's tugs, *Fairmount Summit* and *Fairmount Alpine*. The voyage took 54 days, averaging a speed of 6.9 knots. *Fairmount Summit* and *Fairmount Alpine* assisted with launching and installation activities once the jacket reached its destination, Noble's Tamar gas field southeast of Cyprus.

P PSVM starts production

Production has begun from BP and Sonangol's PSVM development in block 31, off Angola. The PSVM development, BP's second operated development in the country, consists of four oil fields: Plutão, Saturno, Vénus, and Marte. Three wells at the Plutão field are expected to increase production at PSVM to approximately 70,000b/d of oil. Production will increase to 150,000b/d once Saturno and Venus fields along with Marte field come online.

Q HPHT technology to India

Cairn India contracted GE Oil & Gas to supply the Ravva oil and gas field off the coast of Andhra Pradesh with HPHT wellhead technology, mudline systems, spare units and services for the field. "We see HPHT technology as a key for the next stage of development, and reliable, proven HTHP technology is of paramount importance to the success of the project," said Dr Sunil Bharati, spokesman for Cairn India.

R Ichthys commissioning

Cegelec Oil & Gas Services won two commissioning contracts in January for the Ichthys project off the coast of Western Australia. Under the scope of the three-year contracts, Cegelec will perfor pre-commissioning and commissioning engineering of both the offshore central processing facility and the Ichthys FPSO. Production at Ichthys is expected to begin by 2016.

S Arctic pact

ExxonMobil and Rosneft signed a new pact last month, enabling ExxonMobil to gain seven new exploration blocks in the Chukchi, Laptev and Kara Seas, an area totaling 600,000 sq km. In turn, Rosneft will have the option to take 25% of ExxonMobil's Point Thomson Unit servicing the natural gas and condensate field on Alaska's North Slope.

T Restoring Terra Nova

Suncor Energy resumed production at the largest of three drill centers at the Terra Nova complex, off Newfoundland, following the completion of dockside maintenance. A second drill center was connected in January and is currently being commissioned.

Make way for Jupiter

Australian exploration company Jacka Resources hired the *GSP Jupiter* jackup rig to drill and test its Hammamet West-3 exploration well off Tunisia, which is expected to spud later this month. The rig is *en route* to Tunisia and will require the partial removal and replacement of the jackup legs in order to pass through the Bosporus into the Mediterranean Sea, Jacka says.

Arabian construction

Saudi Aramco awarded Saipem a lump sum contract extension for the development of the Arabiyah and Hasbah gas fields in the Persian Gulf. The project's scope includes construction work on the fields' trunklines.

Spaoh-2 spudded

BC Petroleum spud the Spaoh-2 well last month. It will target a total depth of 2710m subsea, is the third well in a multi-well appraisal drilling program in the Balai Cluster off east Malaysia.

Chinese duo

Chevron subsidiary Chevron China Energy and China National Offshore Oil Corp (CNOOC) signed production sharing contracts for two shallow water exploration blocks in the South China Sea. Chevron will hold 100% interest during the exploration phase and be responsible for conducting 3D seismic data surveys for blocks 15/10 and 15/28 in Xijiang Sag of the Pearl River Mouth Basin. CNOOC retains the right to participate up to 51% working interest if commercial discoveries are made.

Cantarell extension

Mexico's Cotemar Group secured short contract extensions for three Prosafe SE accommodation vessels. The three

semisubmersibles are currently stationed at Pemex's Cantarell field. Bareboat charter contracts for *Safe Britannia*, *Safe Lancia*, and *Jasminia* semisubmersibles have been extended until end-March, mid-September, and late May, respectively. The total value of these latest extensions is about US$21 million.

Ecuadorean seismic

WPG Group initiated the acquisition of 2D and 3D surveys last month in Ecuador's transition and shallow water zones for the State Sevmorgeo Company (SMG). SMG is utilizing Fairfield Z-700 ocean-bottom nodes in combination with portable sources provided by WPG.

Contract Briefs

Tenaris renewed a long-term supply deal with Brazil's Petrobras last month. Under the agreement, Tenaris will supply large diameter casing pipes with TenarisHydril Wedge Series 500 premium connections and other products until 2017.

Shell has awarded Subsea 7 a US$135 million contract for work on its Fram oil and gas development located 220km east of Aberdeen, Scotland. Subsea 7 will handle the engineering, procurement, fabrication, and installation of a 4.5km in-field pipeline bundle measuring 44in in diameter, with integrated manifolds and tie-in structures.

TGS announced it will charter the 12-streamer *Polarcus Asima* for a six-month period. TGS will utilize the ship during an acquisition of a 3D multi-client survey covering 7800km^2 of the Sunfish acreage in Harper Basin, off Liberia. TGS will perform data processing and make the data available to clients by Q4 2013 prior to the Liberia 2013 Bid Round.

Wood Group Kenny won a US$8.6 million contract from Inpex Maselato perform FEED work for the subsea production facilities at the Abadi LNG project off Indonesia. The contract involves the subsea, umbilical, riser and flowline systems, including subsea structures and equipment.

Statoil contracted Heerema Fabrication Group's Vlissingen yard for the engineering, procurement, and construction of a fixed jacket and pre-drilling module for the Dagny field development in the central North Sea. The 16,000-ton jacket will be the largest launch jacket built at the yard.

Latin America's Telmex contracted Offshore Marine Management to supervise and assist with repairs to the shore-end section of an existing fiber optic connection between the Mexican mainland and Cozumel. Offshore Marine Management installed protective pipe onto the submarine cable section, providing protection and expanding the pipe's lifespan.

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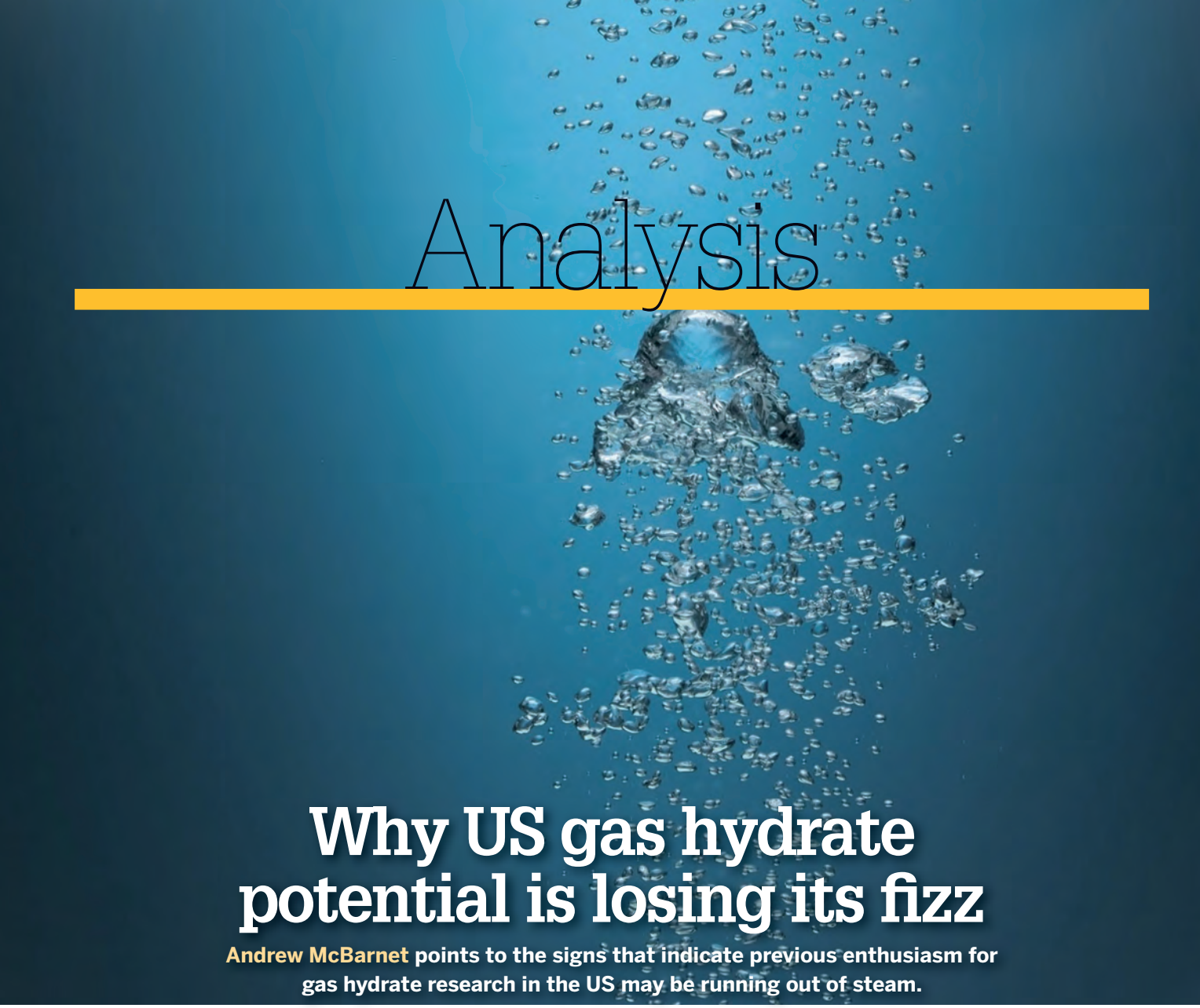


Analysis

Why US gas hydrate potential is losing its fizz

Andrew McBarnet points to the signs that indicate previous enthusiasm for gas hydrate research in the US may be running out of steam.

The announcement last month of significant progress in a key gas hydrates research project offshore Japan featuring some US participation scarcely made it into the oil industry news cycle. The scant coverage suggests that interest in the promise of gas hydrates as a major future energy source for the US has once again been consigned to the back burner. This is despite the massive potential resource availability in the US.

In 2008, the US Minerals Management Service, now the Bureau of Ocean Energy Management (BOEM), suggested that there were about 11,00034,000Tcf of methane in-place in hydrate form in the northern Gulf of Mexico, with a mean value of 21,444Tcf. The assessment made no estimate of how much of this was technically or economically recoverable, but did comment that about 6700Tcf of the resource occurs in relatively high-concentration accumulations in sandy sediments which would be most likely producible. Subsequently, in 2011, BOEM released some new estimates for the lower 48 US Outer Continental Shelf, but the volumes of possible gas remain huge. Also, in 2008, the US Geological Survey (USGS) estimated that there is approximately 85Tcf of undiscovered, but technically recoverable, natural gas resource in sediments within and beneath the permafrost on the North Slope of Alaska.

According to a National Energy Technology Laboratory (NETL) briefing, the figures compare with the total US natural gas resource, excluding hydrates, amounting to 2074Tcf, based on estimates reported by the Potential Gas Committee. It says, 'If one-third of the natural gas in-place in methane hydrate in sandy sediments of the Gulf of Mexico becomes technically recoverable, the US could double its total natural gas resource.'

Any incentive to step up investment in the current modest research efforts

to explore the potential value of gas hydrates to the US energy mix appear to have been sapped more than anything by the large scale exploitation of the North American shale gas plays in the last few years, likely to be replicated in other parts of the world. This unpredicted turn of events has transformed thinking about the US energy balance over the next few decades leaving gas hydrates somewhat out of the calculations.

Hydrates excitement

However, there are some countries in the world, not just Japan, where any advance in understanding of gas hydrates is likely to cause at least a flicker of excitement. China, Korea, and India, for example, all face major challenges to meet energy demand from indigenous sources, driven by rapid economic growth and increasing home consumption. They are all hanging some of their hopes on gas hydrates, and have been accelerating their efforts in this department. So, the implications of the latest results from Japan will be closely watched in some quarters.

The project in question is an ongoing program in the deepwater Nankai Trough, offshore Japan. After an initial success with the 1999/2000 Nankai Trough Project, in 2001, the Ministry of Economy, Trade & Industry (METI) launched a new major project entitled 'Japan's Methane Hydrate Exploitation Program,' operated by the Methane Hydrate 2001 Consortium (also known as MH21), to evaluate the resource potential of deepwater gas hydrates in the Nankai Trough area, much like the goals of the previous Nankai Trough project. The project is intended to go much further and promote the technical development and recovery of gas hydrate, and to provide a long term stable energy supply to Japan. On behalf of METI, the Japan Oil Gas & Metals National Corporation (JOGMEC) and the Agency of Industrial Science & Technology (AIST) have developed a highly integrated gas hydrate research and development program including both basic research and field studies. This program is now built around an 18-year plan to be completed in 2018 (initially planned as a 16-year program but the goals of this effort were revised in 2008).

In fact, US scientists have got a finger on the pulse of this most advanced gas hydrate program in the world, thanks to ongoing collaboration on methane hydrate research through the US Department of Energy (DOE) and the Gulf of Mexico Gas Hydrate Joint Industry Project (JIP). In this particular segment of the Japanese project, the US Gas Hydrate Project (part of USGS) and the School of Civil & Environmental Engineering at Georgia Tech have played a key role.

The latest achievement has been the successful

borehole recovery of sediment containing gas hydrates – pressure cores – delivered with new technology designed to allow scientist to better study the gas hydrates in lab conditions, preserved as they were in their natural state in the subsurface where they occur. Gas hydrates, for those unfamiliar, are defined as ice-like substances formed when methane, and sometimes other gases, combine with water at specific intermediate temperatures and low temperature. They are found in the marine sediments beneath the ocean floor on the edge of continental shelves and in sediments within and beneath permafrost areas. It is the pressure-temperature conditions that keep the gas hydrates stable, *ie* intact with the gases contained in a solid form.

The pressure sampling in the Eastern Nankai Trough is part of a reservoir characterization project, ahead of a first production test planned for this year. The test site is in 1000m water depth, where the first exploratory campaign, begun nearly 10 years ago, identified turbiditic sediments, several tens of meters thick, containing concentrated methane hydrate some 300m below the seabed. As reported by JOGMEC and AIST, a dedicated borehole was drilled, in 2012,

Yoshihiro Konno (AIST) and David Mason (USGS) at work on pressure coring in Japan.

WILLIAM WINTERS/USGS

in addition to part of a production well and two temperature monitoring boreholes. The purpose was to recover pressure cores for research from a number of multi-disciplinary perspectives including geological, geochemical/mechanical, microbiological, and petrophysical.

Coring technology

The pressure core recovery itself was not new, although some improvements were made to the system. However, some of the cores preserved under pressure will be analyzed using, for the first time, pressure core characterization tools (PCCTs) developed by Georgia Tech and operated in conjunction with USGS. The university designed its first gas hydrate research equipment, the Instrumented Pressure Testing Chamber (IPTC), in 2004, under the auspices of the DOE/Chevron Gulf of Mexico JIP to measure seismic, strength, and electrical properties of hydrate bearing sediments recovered in pressure cores. This innovation was employed in conjunction with the Pressure Core Analysis & Transfer System (PCATS), designed by UK company Geotek, which can transfer cores through an X-ray CT scanner for non-destructive measurements of density and p-wave velocities. The IPTC/PCAT tools were in operation for the Gulf of Mexico JIP Leg 1 expedition, offshore India, as part of India's Natural Gas Hydrate Program, and offshore Korea for sampling by Ulleung Basin Gas Hydrate Program.

This year's production test already underway is the first of its kind, and is a big deal for Japan, and arguably for the world, as the first marine test. It helps to put the country on the path to developing technology that can produce viable quantities of gas from hydrates. Commercially it may not make a lot of sense in current market conditions, but strategically this may be important for Japan, especially now that the nuclear option is most unlikely to be considered.

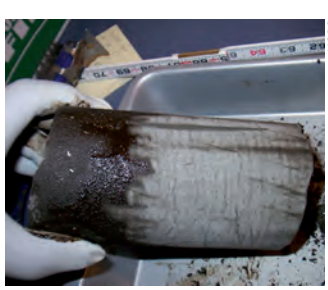
Dr Carolyn Ruppel, USGS gas hydrates project chief, says: "We are just pleased that we have been able to collaborate with our Japanese colleagues on one component of this important development in gas hydrate research."

Gulf of Mexico research

In different circumstances the first offshore production test on the scale envisaged might have taken place in the Gulf of Mexico. Following various US and international test projects in the 1990s, gas hydrate research picked up momentum in the US following the Methane Hydrate R&D Act of 2000. This enabled DOE to involve industry, academia, DOE labs, and six federal agencies, of which USGS was one, in dedicated research projects.

Such research has traditionally been broken down into three broad areas of interest: 1) the energy resource potential; 2) possible effects of gas hydrate 'disassociation' on climate change; and 3) the geohazards.

In fact the Gulf of Mexico JIP Leg 1 offshore expedition in 2005 addressed the potential geohazards posed by gas hydrates in fine-grained sediments for deepwater exploration and production operations.



USGS

An Alaskan core sample.

The theory was that commercial activities that disrupt hydrate-bearing sediments or sediments charged with free gas beneath the gas hydrate stability zone (GHSZ) could encounter numerous potential hazards.

Essentially the conclusion was that the industry already had the issue pretty much covered, and many of the possible drilling scenarios had already been encountered and successfully managed.

Focus of the second Gulf of Mexico JIP Leg 2, in 2009, was designed to expand the understanding of gas hydrate in the Gulf of Mexico by specifically targeting systems thought to include high-quality (thick, porous, and permeable) sands. These are the most likely to contain good concentrations of gas hydrate.

Results from this expedition supported the predicted potential of gas hydrate as an energy resource. Gas hydrate was found at saturations ranging from 50% to more than 90% in high-quality sands.

The drilling (and logging-while-drilling) at Walker Ridge block 313 and Green Canyon block 955 discovered the most promising marine gas hydrate accumulations in the world, according to Dr Timothy Collett, co-leader of the expedition from USGS, who has spent most of his career on research into gas hydrates as a potential energy resource. >

Scientific results from this second Gulf of Mexico field trip have all been published, but the intervening years since the 2009 initiative seem to have put the brakes on momentum for further major initiatives. For example, there is no talk of moving to prepare a production test which would be the logical follow-on from JIP Leg 2, probably preceded by a test in Alaska. It has been announced that no further drilling is planned. This implies lack of support from oil companies, who would be an essential partner in any further work. A number of factors seem to have coalesced against raising the tempo of research. A tanking economy at the time didn't help, nor did the Macondo incident, in 2010, which undoubtedly brought all oil companies' risk adverse instincts to the fore, and made gas hydrates seem an unnecessary journey into uncertainty. All this, and the advent of shale gas opportunities: it could hardly fail to engender an attitude of 'why bother?'.

The DOE and the USGS continue to work with BP, and a team of participants from industry, government, and academia, to evaluate and test the producibility of methane from hydrate in Arctic Alaska. A Mount Elbert stratigraphic test well, drilled in 2007, confirmed the existence of 60-75% hydrate saturation within reservoir quality sands in targeted stratigraphic intervals. A short-term downhole test proved the ability of the formation to release gas through depressurization, the first time this had been accomplished on the North Slope.

The drilling rig during the Mount Elbert stratigraphic test.

USGS

The DOE has also partnered with ConocoPhillips and JOGMEC to conduct a test of natural gas extraction from methane hydrate using a production technology, developed through laboratory collaboration between the University of Bergen, Norway, and ConocoPhillips, for the 2012 Ignik Sikumi Gas Hydrate Field Test in Arctic Alaska. The team injected a mixture of carbon dioxide and nitrogen into the formation, and demonstrated that this mixture could promote the production of natural gas. This test is said to have been the first ever field trial of a methane hydrate production methodology, whereby CO_2 was exchanged in situ with the methane molecules within a methane hydrate structure. Results of the depressurization phase of this project are being used to design the long term gas hydrate production test planned for Alaska. However, it is understood that ConocoPhillips will not be continuing its involvement in this project, citing among other things the shale gas priority.

Lower priority

It is pretty obvious from the last round of DOE funding, in 2012, that gas hydrate research does not rate as a high priority on the Obama Administration's 'all of the above' policy to maximize development of US energy resources. A total of $5.5 million is being spent on 14 new research projects under the supervision of NETL. Admittedly, this is in addition to ongoing project funding for gas hydrate research by DOE and a number of government agencies, but it is not a lot of money. Six of these are designed to capitalize on the reservoir characterization field work undertaken during the Gulf of Mexico JIP Leg 2, in 2009. Several other projects are aimed at further study of the nature and occurrence of gas hydrate in settings impacted by changing climates. This interest seems partly a response to the alarmist school of environmentalists, who insist that our warming climate could cause gas hydrates in the Arctic environment to break down (dissociate), releasing the methane that they now trap.

While acknowledging the need for further research, Dr Ruppell does not go along with this type of catastrophic scenario. She and colleagues have argued that only a fraction of all likely gas hydrate deposits are found within or beneath permafrost. The top of the gas hydrate stability zone in areas of thick permafrost typically lies at greater than 200m depth, and these permafrost-associated gas hydrates are expected to be stable for thousands of years under most climate warming scenarios.

The subset of permafrost-associated gas hydrates that occurs in shallow, unglaciated, circum-Arctic Ocean shelves lies at the same depths. The prevailing conditions may render these gas hydrates more susceptible to warming-driven dissociation, but the timescales involved and factors that mitigate the release of this methane to the atmosphere make it unlikely that there will be an Arctic methane catastrophe attributable to destabilization of methane hydrates, according to Dr Ruppel.

Such debates are just one other indication that gas hydrate study in the US has, for the time being, returned to its home in the academia after its brief foray into the mainstream through oil industry support. OE

Quick stats

OE's at-a-glance guide to offshore hydrocarbon reserves and key offshore infrastructure globally is updated monthly using data from leading energy analysts Infield Systems (www.infield.com).

New discoveries announced

Depth range	2010	2011	2012	2013
Shallow (<500m)	93	104	68	3
Deep (500-1500m)	29	24	22	0
Ultradeep (>1500m)	32	20	34	1
Total	154	148	124	4

Note: Operators do not announce discovery dates at the time of discovery, so totals for previous years continue to change.

Reserves in the Golden Triangle

by water depth 2013-17

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Brazil			
Shallow	31	3880.75	2180.00
Deep	18	3810.00	2505.00
Ultradeep	42	14,554.20	21,240.00
United States			
Shallow	17	64.65	1153.50
Deep	27	2512.37	2650.78
Ultradeep	26	3596.75	4060.00
West Africa			
Shallow	157	3734.60	19,882.81
Deep	51	7975.00	8440.00
Ultradeep	21	3110.00	3390.00
	390	**43,238.32**	**65,502.09**
(last month)	(405)	(43,615.82)	(70,472.09)

Greenfield reserves

2013-17

Water depth	Field numbers	Liquid reserves (mmbbl)	Gas reserves (bcf)
Shallow (last month)	1367 (1369)	79,451.73 (81,089.90)	832,101.61 (853,004.33)
Deep (last month)	182 (187)	18,261.24 (18,796.24)	111,621.48 (101,021.48)
Ultradeep (last month)	109 (106)	21,949.95 (21,661.95)	67,237.00 (67,257.00)
Total	**1658**	**119,662.92**	**1,000,380.09**

Pipelines

(operational and 2012 onwards)

	(km)	(last month)
<8in		
Operational/ installed	41,208	(41,195)
Planned/ possible	22,894	(23,014)
	64,102	(64,209)
8-16in		
Operational/ installed	76,966	(87,446)
Planned/ possible	47,095	(47,828)
	124,061	(123,965)
>16in		
Operational/ installed	87,538	(87,446)
Planned/ possible	48,139	(47,828)
	135,677	(135,274)

Production systems worldwide

(operational and 2013 onwards)

Floaters		(last month)
Operational	269	(267)
Under development	46	(45)
Planned/possible	326	(325)
	641	(637)
Fixed platforms		
Operational	9828	(9806)
Under development	151	(147)
Planned/possible	1453	(1480)
	11,432	(11,433)
Subsea wells		
Operational	4357	(4329)
Under development	415	(413)
Planned/possible	5917	(5915)
	10,689	(10,657)

Global offshore reserves (mmboe) onstream by water depth

	2011	2012	2013	2014	2015	2016	2017
Shallow (last month)	10,462.16 (10,310.41)	9415.75 (9770.68)	68,701.61 (71,093.27)	31,344.31 (34,546.21)	40,285.68 (38,629.13)	31,984.21 (29,615.11)	54,205.43 (55,732.55)
Deep (last month)	1316.73 (1316.73)	2618.75 (2618.75)	3930.65 (4039.46)	6362.53 (6362.53)	5901.90 (5793.08)	5520.23 (6448.96)	14,389.76 (15,864.92)
Ultradeep (last month)	119.94 (119.94)	952.73 (1515.62)	3039.86 (2674.60)	3137.31 (2936.68)	3177.35 (3143.82)	6820.52 (7018.35)	17,641.38 (17,751.44)
Total	11,978.84	12,987.22	**75,672.12**	**40,844.16**	**49,364.92**	**44,324.85**	**86,236.57**

The recovery challenge

In 2007, the Tordis SSBI was installed in 650ft of water.

Production from subsea wells is growing in importance in many operator portfolios. As easily accessible oil is depleted, subsea processing offers a compelling solution to economically produce in a variety of challenging conditions. Worldwide, there are more than 4000 subsea wells onstream today and FMC projects that this number will grow to nearly 7000 by 2017. In fact, analysts expect the number of subsea wells coming onstream between 2013 and 2017 to increase by 68% over the previous five-year period.

For operators, extracting as much of the original oil-in-place as possible is critical.

While conventional oilfields report typical recovery rates between 30-60%, subsea wells often fall below that mark, reporting recovery rates less than 40%. Just a 1% increase in subsea recovery can deliver an additional 10mmbo of production from a typical large field. This additional production can dramatically affect project economics, improving the viability of greenfield projects or ensuring that brownfield installations continue operating profitably.

For greenfield applications such as long distance step-outs in deepwater, in the Arctic or challenging reservoirs with low-energy or heavy oil, the increased production rates and recovery can be moving forward. The Arctic holds more than 90 billion bbl of undiscovered oil.

For brownfields, increased oil recovery (IOR) can be critical to keep the field operating economically despite depleting reservoir energy and increasing water cut.

Enabling technologies

To improve recovery rates, operators often turn to IOR techniques. These are typically deployed during, or after, primary depletion and can be considered basic reservoir management techniques to improve sweep and accelerate production from the reservoir. These techniques often include:

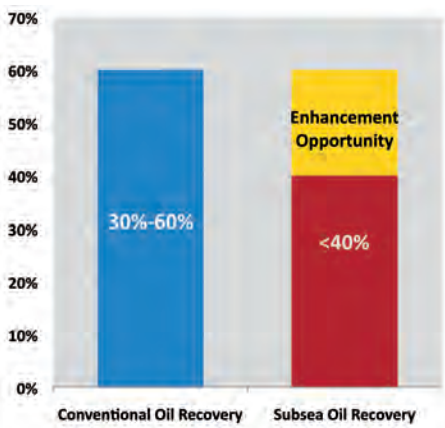
- Adding reservoir drive energy via water or gas injection.
- Modifying water injection chemistry to reduce interfacial tension and rock wettability to reduce residual oil saturation (EOR technique).
- Removing back pressure via boosting or artificial lift.
- Workover, stimulation or re-entry of existing wells to improve inflow and/or access new targets.
- Creating more penetration points to access bypassed areas of the reservoir.

These techniques can each increase recovery by 3-10% of original oil-in-place and can extend a field's productive life by several years or decades.

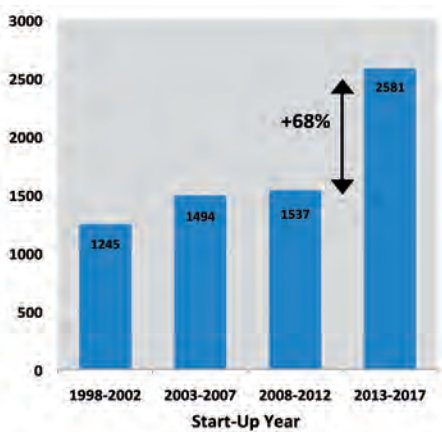
To achieve these results, a number of technologies are required:

- Subsea pumping and subsea separation are used to reduce back pressure in subsea oilfields. >

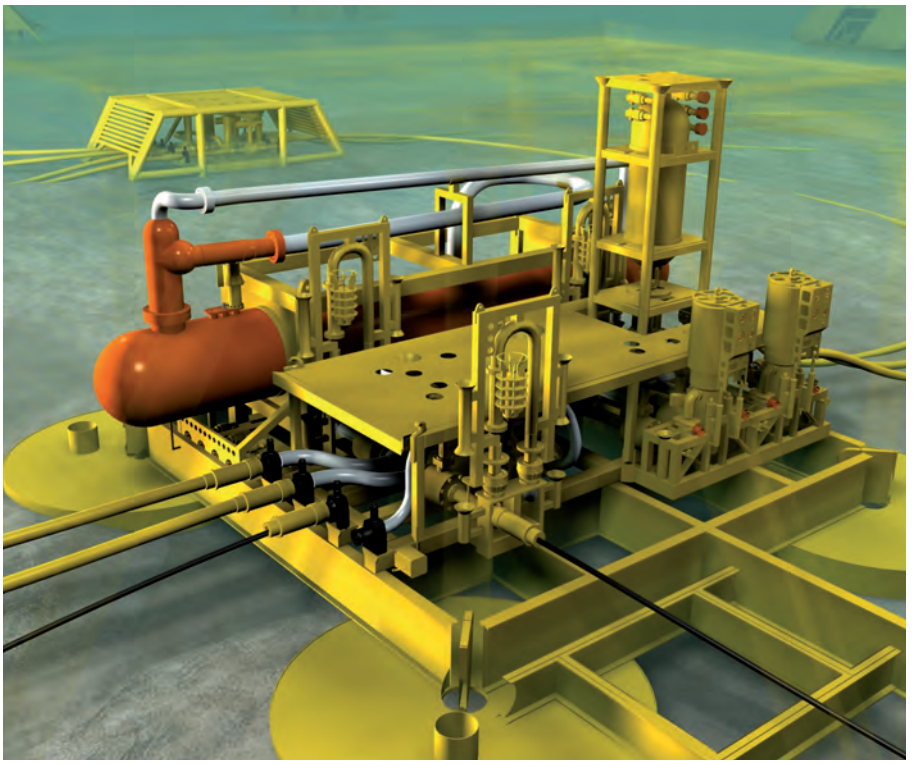
Increased oil recovery techniques serve as enhancers for maximizing production from brownfields and enablers to improve the economic viability of greenfield developments. **Chris Shaw** of FMC Technologies examines the issues.



The recovery challenge.



Global subsea wells onstream.



Statoil expects to increase ultimate oil recovery at the Tordis field from 49% to 55% of original oil-in-place, resulting in an additional 35mmbo of oil.

- Subsea gas compression is deployed to reduce back pressure in large subsea gas fields.
- Subsea water injection pumps are installed to increase reservoir drive energy and aid oil displacement.

Subsea separation has been effective in delivering more efficient liquid boosting and cost-efficient hydrate management, and is a potential enabling technology for longer step-outs where cold-flow concepts can be employed.

Globally, five subsea separation systems are currently installed. Separation systems for two-phase (liquid/gas), three-phase (oil/water/gas), and four-phase (oil/water/gas/sand) separation employ a variety of separator types including horizontal, vertical, and caisson separators.

Operators have been using seabed pumps for many years to reduce back pressure on the reservoir; this increases flow rates and total recoverable reserves. Whether the pumps are used for boosting or injection, they are widely believed to be the most mature subsea processing solution. A variety of pump types, including rotor-dynamic, positive displacement, and centrifugal, have been used in different applications. The most powerful subsea, multiphase pumps available today provide more than 3MW of boosting power at the seabed.

Subsea gas compression represents a major technological leap for the E&P industry. Gas compression offers a number of advantages as it enables development of gas fields without the need for topside facilities, manages flow assurance issues such as slugging, and contributes to improved production and recovery. The solution requires a system that includes compressors, pumps, scrubbers, coolers, and controls.

Using compressors upstream of LNG process facilities adds value through delay of production decline, due to poor turndown capability of LNG processes. Statoil will be the first operator to deploy this technology to increase recovery rates from its Asgard field in the North Sea with anticipated start up in 2015.

Today, subsea compression is being used for long-offset subsea-to-beach situations, where flow rates are high and the differential pressure is sufficient to overcome the friction losses in the transport pipeline. The use of gas compression could be broadened to include lower rates and sufficient pressure rise to enable gas injection.

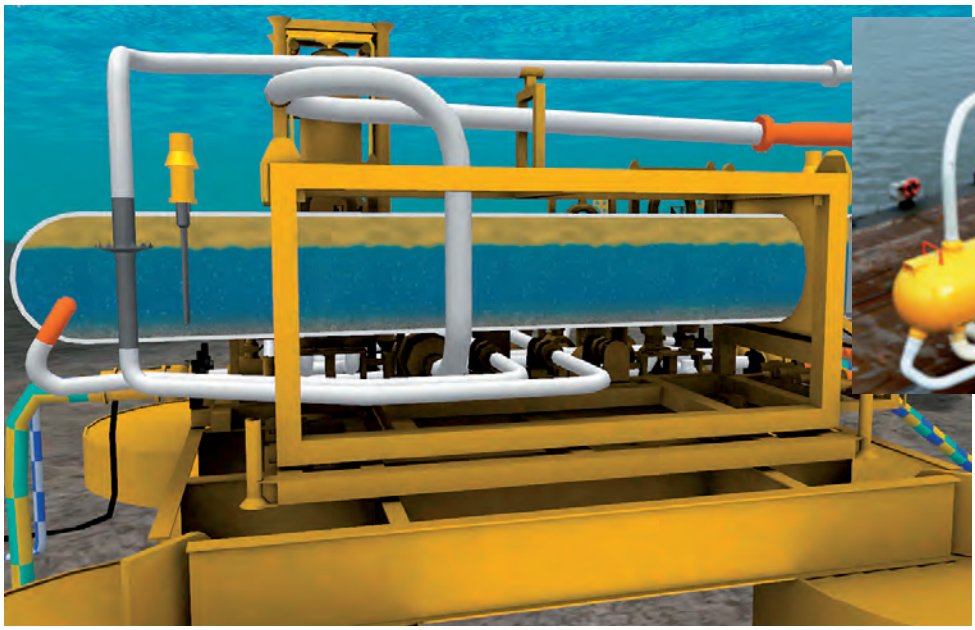
Additionally, future technology developments are required for power distribution, instrumentation, automation, and control. These advancements are critical to make IOR possible in more remote and difficult to access environments such as the Arctic, where ice can cover the surface for much of the year.

Increased recovery in greenfield

FMC Technologies has been closely involved with gas/liquid separation and boosting since 2005 when several projects were in their appraise-to-select phase. Today, three projects use gas liquid separation and pumping, including Shell's Perdido and Parques de Conchas (BC-10), and Total's Pazflor.

Gas/liquid separation projects aim to achieve a number of advantages over multiphase pumping alone. The primary advantage of deploying a separation and pump system is the improved hydraulic efficiency of the pump. Additional benefits include increased pressure rise through the pump and improved flow assurance.

Application of gas/liquid separation to a full field development from day one can be an effective solution because of impressive economic benefits. Many of the competing solutions such as multiphase pumping and gas-lift may not deliver the rate and recovery offered by the processing option. It is well known that gas/liquid separation offers the lowest possible back pressure on the reservoir. When coupled with the great operational flexibility (*ie* ability to manage changes in production index, gas-oil ratio and



The Tordis separator is designed to handle almost 190,000b/d of liquids operating at around 500psi. It can remove as much as 100,000b/d of water to a standard of less than 1000ppm of oil.

water cut), and the system's ability to mitigate hydrate and slugging issues, the application of gas/liquid separation and pumping to a full-field solution delivers many operational benefits.

Increased brownfield recovery

FMC Technologies supplied the world's first full-scale commercial subsea separation, boosting, and injection system (SSBI) to Statoil in 2007 for its Tordis IOR project. As the key component, the subsea separation, boosting, and injection system provides Statoil with a cost effective means to increase ultimate oil recovery to 55%, adding more than 35mmbo reserves.

North Sea oil output now depends heavily on IOR techniques. Projects typically must overcome challenges involving diminished reservoir pressure and large amounts of water in the production stream. These challenges have been particularly difficult at Tordis. Without adequate reservoir pressure, the oil and gas cannot flow from the subsea wells to the surface processing facility. Large water volumes reduce overall production efficiency and may exceed processing facility water-handling capabilities. When these problems cannot be overcome at a reasonable cost, fields can be abandoned.

The subsea separation, boosting and injection system gave Statoil the solution needed to overcome these challenges at Tordis, where the water depth is 650ft. The separator at the SSBI station is designed to handle almost 190,000b/d of liquids operating at around 500psi. It can remove as much as 100,000b/d of water to a rated cleanliness standard of less than 1000ppm of oil. A single-phase subsea pump boosts the water to 1900psi for injection into a low pressure aquifer.

As much as 35mmcf/d of gas are separated from the oil and water, most of it by a cyclone at the separator inlet. Incorporating the cyclone minimizes the size of the separator vessel, facilitating its ability to be installed or retrieved to the surface. The gas is routed through bypass piping and then recombined with the de-watered oil. An electric-powered, multiphase pump boosts the oil and gas mixture to 1000psi for the 16-mile (25.7km) trip to the Gullfaks field for processing. The separator is also designed to remove up to 1100lb/day of sand from the separator. This is mixed with the separated water for injection downstream of the injection pump.

The subsea separation, boosting, and injection system enhances production by reducing back pressure on the Tordis wells and thereby facilitating fluid flow from the reservoir. Accelerated production from Tordis results in too much water for the production facilities at Gullfaks C to manage. Separation and disposal of the water subsea enables an increased production rate.

Increased oil recovery from subsea fields represents a huge opportunity to enable production from greenfield developments and to ensure that brownfields can continue to operate profitably. To improve recovery rates in subsea fields, a number of key technologies are required in the areas of subsea separation, pumping and compression. Using these technologies will enable operators to increase recovery by 3-10% of original hydrocarbons in place and can extend a field's productive life by several years. OE

Chris Shaw *is presently the field development manager – IOR Systems for FMC Technologies in Houston, Texas. Shaw joined FMC in 2007 to lead subsea processing technology commercialization initiatives in the western region.*

Broadband seismic: What the fuss is all about

Andrew Long of Petroleum GeoServices provides a rough guide to the science behind broadband seismic and why it is transforming the possibilities for acquiring high resolution images of the subsurface using towed streamer marine seismic acquisition technology.

In any towed streamer seismic acquisition project there are three considerations regarding the bandwidth of signal from the earth available in the final seismic image product: 1) the frequency bandwidth propagated into the earth from the source array; 2) the frequency bandwidth recovered from the earth in the recorded data; and 3) the frequency bandwidth preserved throughout all processing and imaging steps.

Seismic signals are described in classical terms of amplitude, phase, and frequency content. Each component must be faithfully preserved in order to accurately interpret geological structure and stratigraphy, and to accurately predict lithology and fluid distribution during reservoir characterization. The latter pursuit benefits in particular from very low frequency amplitudes being recovered from the earth. A generic definition of 'broadband seismic' thus describes an acquisition and processing system with source and receivers which enhances and preserves the bandwidth at both low and high frequencies in a pre-stack amplitude and phase-compliant manner so that subsequent processing and interpretation can utilize all the information contained in the signal from the earth.

'Ghosts'

Unwanted reflections from the free-surface of the ocean continuously interfere in a constructive and destructive manner with the seismic wavefield propagated into the earth from a source array. The source wavefield reflected from the surface (the 'source ghost') is a time-delayed and opposite polarity version of the source wavefield propagated directly from the source array into the earth, and the two wavefields propagate together in a coupled manner. The net effect is that the frequency bandwidth propagated into the earth contains significant notches at periodic frequencies, and the notch frequencies are a function of both source depth and emission angle (measured with respect to vertical).

Similarly, the receivers (along each streamer) record two versions of the seismic wavefield scattered back from the earth, coupled together and interfering in a continuously constructive and destructive manner. The wavefield reflected downwards from the free-surface of the ocean (the 'receiver ghost') is referred to as the 'down-going' wavefield, and is a time-delayed and opposite polarity version of the 'up-going' wavefield. The wavefield recorded with conventional hydrophone-only streamers is a scalar measurement of pressure; the 'total pressure', which is the sum of the up-going and down-going pressure wavefields. The recorded total pressure wavefield contains significant notches at periodic frequencies, and the notch frequencies are a function of both receiver depth and emergence angle (measured with respect to vertical). So collectively, conventional seismic data contains frequency notches related to both source ghost and receiver ghost effects. These effects notably penalize the low and high frequency content in seismic data, resulting in a limited frequency bandwidth being recovered from the earth.

Physics describes how any pressure wavefield can also be defined in terms of the derivative of pressure normal to the wavefront; measured in units of particle velocity. *Figure 1* (*shown overleaf*) illustrates how the receiver ghost notch frequencies are complementary for pressure and particle velocity wavefields, and how the notch frequencies change as a function of emergence angle. There is usually no usable information in the vicinity of the spectral notches, so any processing-based solution to recover information in these parts of the spectrum must be based on reconstructing the data that *>35*

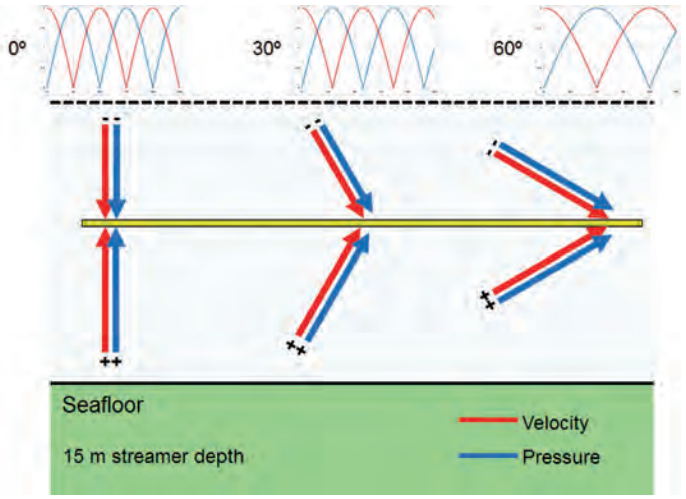


Figure 1 illustrates how the pressure (blue) and particle velocity (red) amplitude spectra are complementary when measured at the same depth and location ('collocated'). Periodic notches in both spectra are related to the receiver depth and the angle of emergence of the seismic wavefield. As the emergence angle increases (vertical propagation means zero emergence angle), the notches move to higher frequencies.

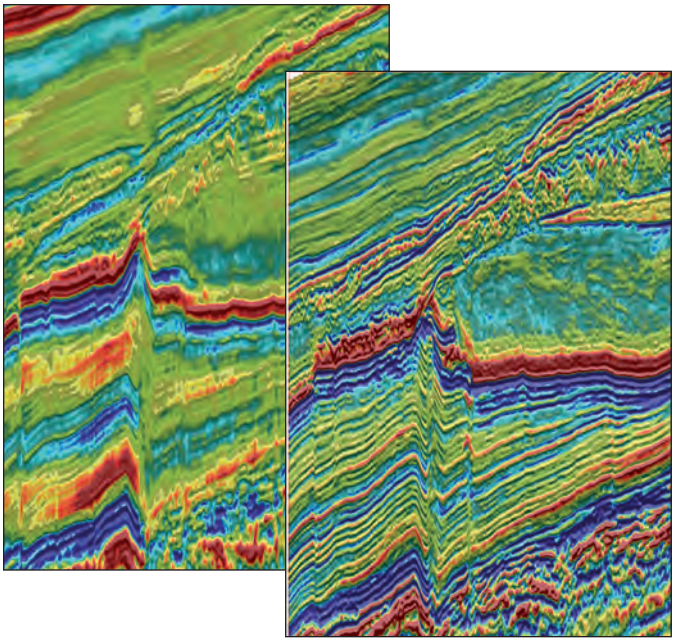


Figure 2. The image on the left is the result of seismic inversion applied to conventional seismic data containing both source and receiver ghost effects. The color scale represents 'P impedance': the product of compressional velocity and density. In contrast, the right image represents the ghost-free result provided from PGS GeoSource and dual-sensor GeoStreamer technologies. Note the improvements in resolution on the right.

Broadband revolution

PGS kick-started the broadband revolution in 2007 when they found an engineering solution to the long-cherished industry ambition of towing collocated pressure and particle velocity sensors in a streamer. Thus, the receiver ghost effects can be completely removed, and new opportunities are created for processing, reservoir characterization and interpretation. In the six years since GeoStreamer was launched, the service company competitors have also launched a diverse family of broadband solutions using hydrophone-only streamers towed with either flat or variable depth profiles, using multi-component streamers, or based upon processing-only solutions. Most recently, industry attention is turning to broadband source solutions so that true ghost-free seismic products can be achieved.

have not been recovered from other parts of the data with higher signal-to-noise (S/N) content. Traditionally, this involves simple 1D deconvolution of the data using a deterministic assumption that the sea surface is perfectly flat, streamer depth is constant, and the earth and water column is homogeneous. Inevitably, such methods are bound to fail as the various assumptions are increasingly violated.

Several acquisition-based methods have emerged that do not seek to mitigate the presence of the ghost notches. They record information with different ghost characteristics such that, when all the data are combined, there is good S/N at a wider range of frequencies:

- Over-under hydrophone-only streamers.
- Variable-depth hydrophone-only streamers.
- Dual-sensor streamers (include vertical component particle velocity sensors).
- Multi-component streamers (include vertical and cross-line component particle velocity sensors).

Each methodology requires rather exhaustive explanation to describe its implementation, but the common element is that a reflection wavefield approximating the true up-going pressure reflection is derived in processing, and the effects of the receiver ghost are removed.

The past couple of years have also seen a variety of source array approaches that deploy source elements at two or more different depths, and processing is able to reduce or remove source ghost effects. It is also noted that a family of processing-based methods have also emerged in recent years that attempt to reduce or remove source and/or receiver ghost effects from conventionally acquired seismic data. Each makes a series of assumptions, but results can be favorable in certain scenarios. *Figure 2* shows a comparison of conventional source and receiver seismic data *vs* ghost-free seismic data.

Using ghost-free data

As demonstrated in *Figure 2*, removing the effects of the source and receiver ghosts significantly improve the frequency bandwidth recovered from the earth, and facilitate high resolution interpretation. Ghost-free data is in fact a prerequisite for many processing algorithms and inversion schemes. Overall, each acquisition and processing 'solution' to mitigating ghost effects and increasing recoverable frequency bandwidth is based upon several assumptions. In 'optimal' survey conditions and in locations with naturally high S/N seismic images the various 'broadband' results may be quite comparable in terms of image quality. But the industry is still in the process of understanding the penalties for reservoir characterization and image quality as various assumptions in each methodology are violated in the acquisition and survey environmental parameters, and in terms of various geological settings and styles.

The most robust broadband seismic solutions are based on an acquisition platform, but even then the industry is still learning how to best process such data. OE

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How Spectrum is changing its focus to win multi-client business

Dolphin's *Polar Duke Explorer* was used to shoot Spectrum's 3D Leb survey.

Rune Eng, president and CEO, provides the answers to why Spectrum is emerging as a key player in the market for multi-client marine seismic surveys and where the company is heading with its business.

OE: Spectrum has been around for a long time. Can you summarize the company's history up to now.

Rune Eng: Spectrum was founded back in 1986 as a seismic processing company. As such, it developed a strong reputation for high-quality processing of challenging data. The main development in the last three or four years has been entry onto the Oslo stock exchange at which time the owners decided to transform the business model from an asset-oriented into a project-oriented business. This led the company to move toward multi-client seismic services.

In 2011 we took the next step in the development of the company by acquiring CGG Veritas's global multi-client 2D library. This has given Spectrum the critical mass where we can use this data to grow the company and fund new projects.

How has the company strategy changed since you joined the company?

Spectrum has moved very rapidly from a specialized seismic processing house into a pure-play multi-client services company with a global library of modern seismic data.

Our focus is now on providing seismic products specifically designed to enhance hydrocarbon exploration within a particular

region. We now employ a team of geoscientists who use geological knowledge combined with any available seismic or remote sensing data to evaluate the hydrocarbon potential of offshore basins around the world.

This information helps us to select prospective regions where our multi-client projects can target plays key to the industry, or identify new, unrecognized potential-plays.

Our seismic expertise then enables us to solve the imaging challenges and allow our clients to make better exploration decisions with the data they purchase.

What is the value of multi-client seismic surveys to oil companies, and how do they differ from exclusive surveys?

Just 10 years ago it was important for oil companies to own their seismic data. They were using seismic as a competitive advantage and ring fencing any proprietary information.

Over the years the culture has changed significantly. We now see a greater level of transparency and oil companies now prefer to compete on the interpretation of data rather than on the data itself. Owning data is expensive and going back 20 years oil companies used to have their own in-house seismic departments and assets.

Operations within oil companies are being increasingly streamlined to allow them to concentrate on their core subsurface assets, rather than supporting businesses such as seismic.

As a result of these changes, 2012 has been a peak year in seismic. Global multi-client investment will exceed US$2 billion. This figure accounts for the revenues from various different multi-client seismic providers such as WesternGeco, TGS, CGG, PGS, Spectrum and, to some extent, Dolphin Geophysical. This growth is thanks to the changes within the structure of oil companies which resulted in the multi-client model becoming more widespread and accepted.

Rune Eng: multi-client man

Before joining Spectrum in 2010 Rune Eng held various executive positions at Petroleum Geo-Services (PGS). He also has a broad range of experience in the seismic industry, principally with Fugro-Geoteam, Sevoteam, an operating company involved in offshore seismic studies, and Digital Equipment Computing (DEC), a company which promotes the use of reservoir simulation in the oil industry.

Rumour has it that you are developing an expanded model for multi-client surveys. What does that look like?

My vision for the company is that when a client enters our interactive data room with a global map of seismic data they will ask for information on a region and we will call in our relevant expert who will have an encyclopedic knowledge of that region. We aim to astound the client with our in-depth analysis of seismic data, play types, and local licensing knowledge of basins from around the world.

I see the seismic value chain as starting with airborne gravity magnetics, moving to 2D lines, infilling those lines, then 3D seismic, and we want to be at the end of this value chain. At all stages we can add value by integrating remote sensing exploration technologies to improve the quality and bandwidth of imaging for the client. If there was a hybrid company that sits between seismic companies and oil companies, that is Spectrum and we are getting there.

Inevitably people will compare you with TGS which has been extremely successful specializing in multi-client. Are you following the same business model?

Spectrum have been likened to a mini-TGS by some industry analysts. That is not something we would argue against. Investors have seen the success of TGS and appreciate the asset-light nature of the business model. For example, we are using technology to the extent that we want to enhance our multi-client data, though we have no major R&D spending.

However, our vision is to differentiate ourselves in the 2D market so that we are delivering companies with prospects rather than data. We have to be able to give them the results of previous wells and tell them why they were dry. We have to think like an oil company and develop exploration play understanding that focuses our risk-reduction workflows. To develop our own exploration plays, we are employing former exploration managers from oil companies who are the 'storytellers' in our company and they bring credibility to the logic and passion of the understanding through the specific experience they have gained.

Without giving away any secrets, where do you see as the most prospective areas of the world for future exploration? Can we expect any surprises like offshore East Africa and the eastern Mediterranean?

Brazil's Northern Margins is an area where we predict big discoveries in

a little explored region and further south in the Atlantic. Namibia's Orange River basin has huge potential soon to be tested by the exploration drill bit. Yet we also consider the more mature basins offshore Norway and the UK to have potential for new paradigm-changing plays to be sought and explored, requiring Spectrum's high quality seismic with an integrated technologies approach to unlock the remaining potential.

Spectrum was the first company to carry out surveys in the eastern Mediterranean many years ago. Why has it taken so long for the industry to wake up to the potential, and is the company's legacy data still relevant?

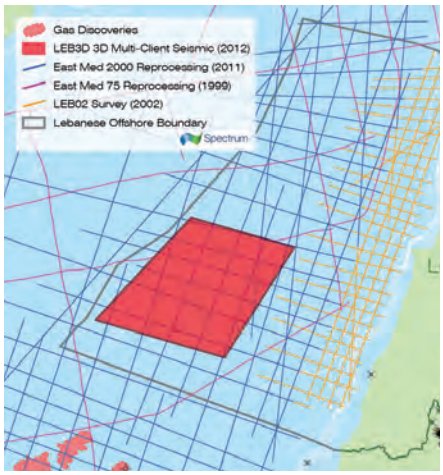
Due to the nature of our multi-client products we must always stay one step ahead, thinking and acting very much like an oil company in the early phase of exploration.

Spectrum has been going to areas like the Mediterranean, South America, and the North Sea to find areas which will eventually become interesting oil provinces. If you had asked anyone five years ago whether Lebanon or Israel would be hot spots for exploration, people would probably have laughed at you. Today this is truly a major E&P region thanks to Noble's gas discoveries in the Levantine basin which are estimated to contain more than 30 TCF of gas. Spectrum was in Lebanon in 2002 back when people were asking us why we were there.

Only when Noble began making significant gas discoveries offshore Israel did the industry really begin to take notice of the eastern Mediterranean.

Even now, we believe that the region is underexplored. Our geoscientists postulate on the possibility that this area may yet produce significant oil discoveries too.

Our head start in the eastern Mediterranean means that we already have some of the best 2D multi-client seismic coverage in the region. This data is now being superseded by our 3D surveys shot toward the end of last year. However, with so many oil companies coming into exploration offshore Lebanon very late in the game, our 2D seismic is now providing an efficient and economical way for those companies to quickly get up to speed. We combine our 2D seismic data along with specially-commissioned well reports, geological analysis reports, and geopolitical information into a Lebanon exploration starter pack – a focused product supplying everything our clients need to begin their successful exploration evaluation of the region.



Offshore Lebanon seismic.

Can we expect Spectrum to develop in any new directions in the future in order to grow?

Our aim is to investigate new ways in which we can enhance the exploration potential of the basins in which we work. Often this is through acquisition of new seismic surveys to generate enhanced imaging or achieve more comprehensive data coverage. However, we are now discovering the benefits of integrating different geophysical disciplines with our seismic data. We have seen EM and gravity gradiometry data provide uplift in the seismic processing of our data in some regions.

If vessel availability becomes an issue in the next year or two, is that a problem for a multi-client survey based company?

There are many suppliers of seismic vessels that we can turn to acquire our datasets, and this is not likely to become an issue for Spectrum. Selected, long-term cooperation agreements and involvement in excellent joint venture projects with vessel operators is proving its worth, and attractive to both vessel operators and Spectrum.

A short term shortage in peak season of vessel capacity may delay the start-up of a multi-client project, but in most cases we can plan for the long term with flexibility in delivery of the project.

What next for Spectrum?

Spectrum aims to be number one in providing 2D multi-client seismic data. We have projects from Asia Pacific, to Africa, Brazil, and the Mediterranean.

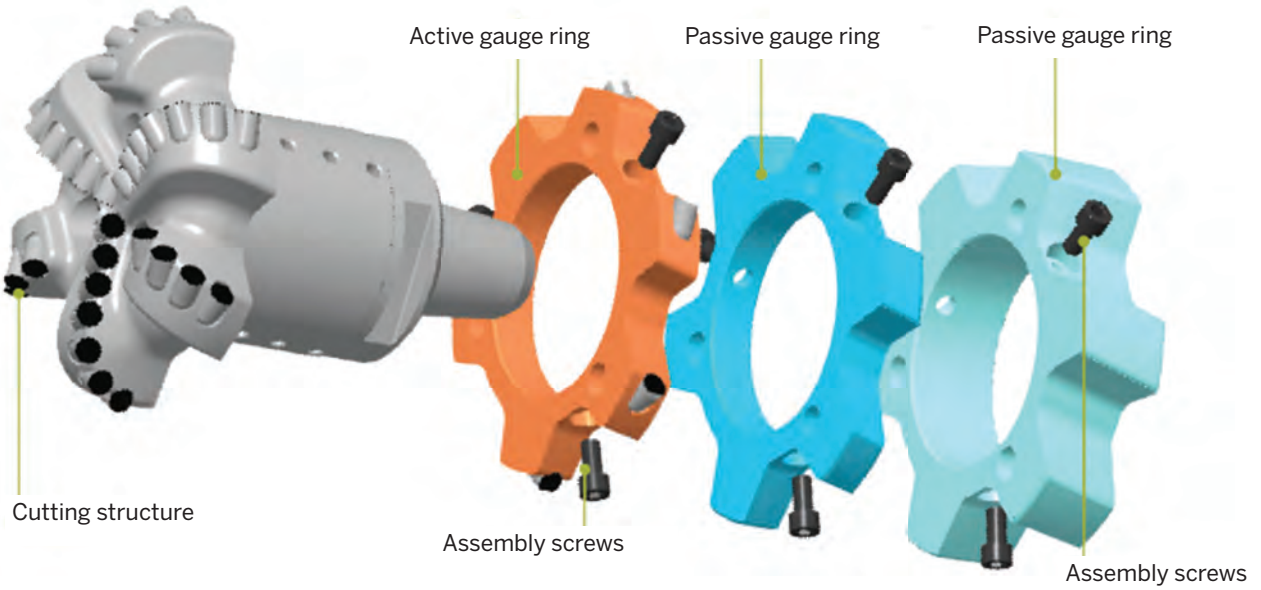
Spectrum will also continue moving into the 3D market. We have already acquired our first multi-client 3D and we will acquire more 3D data in 2013.

Last year is not going to be a record year for very long, 2013 will be better. We have good visibility on projects and on the people who work for us.

Our industry is based on skilled people and although our new organizational structure will be fully tested over the coming months, we now have dedicated people to take care of various regions from Africa to Asia Pacific and this will have a major impact on the growth of the business.

We are working toward becoming that hybrid company sitting between seismic companies and oil companies.

I want our customers and the industry to look on us not as a seismic company, but one which sells prospects to oil companies, integrating technologies to inform the oil companies on where they should explore next. OE



Varel spins patented technology

The last few months have been busy ones for Varel International. The Texas-based drill bit manufacturer celebrated the opening of its Houston technology center and also launched two drill bit lines, the Raider and the Voyager series.

Varel designated the Houston facility as a test lab to further the development of its polycrystalline diamond compact (PDC) and roller cone drill bits. It will use its patented Acoustic Emissions Toughness Testing (AETT) technology to assess the durability of hard materials, such as rock samples and downhole tool inserts. The Houston facility also comes equipped with a vertical turret lathe, scanning electron microscope, and diamond-sample preparation equipment.

Dr Alfa Dourfaye, Varel's technology development manager,

says that the new facility makes the company more attractive for technology joint ventures.

In January, Varel introduced the Raider series PDC drill bit, which underwent acoustic emissions testing with AETT technology. The bit is designed for drilling to total depth through interbedded soft and hard formations of transition zones.

Bits in the Raider series are customizable with cutters matched to the application, which Varel says will minimize wear and improve ROP and footage drilled. The design can include one or two extra rows of cutters per blade to increase diamond density. Raider bits are designed with a tougher cone and stronger nose and shoulder, providing greater stability for transitional drilling.

Last October, Varel also released the Voyager line of PDC bits for directional drilling. The company tested more than 70 gauge configurations and ultimately selected three for the Voyager series.

Varel says the bit is compatible with all available directional drive systems when coupled with custom cutting structures. Varel's western hemisphere product manager, Cary Maurstad, says field testing proved that the Voyager series holds up over the course of the well path, responding smoothly to directional inputs and rock transitions.

AETT technology

Varel's acoustic emissions device uses multiple pressurized chambers, a rock sample, and one or more acoustic sensors attached to the rock sample. The device, which is hooked up to a recorder, tests the rock sample in multiple chambers and at different pressures. The sensors then detect events occurring within the sample.

"This facility allows us to exploit the benefits of the AETT technology, which detects and differentiates variances in diamond quality and performance in a unique and beneficial way," says Federico Bellin, who is listed as the inventor of the technology on Varel's patent. "Multiple types and grades of PDC cutters can be cross compared, yielding a highly predictive valuation of impact toughness."

Audrey Leon


The MHN process complex.

Effective coordination leads path-breaking project at Mumbai High

Recently a major process complex was completed off western India. **Kumar Rudra** and co-authors from Larsen & Toubro discuss the challenges of executing the Mega Process Complex Platform project.

In 2000, ONGC announced its plan for Mumbai High redevelopment, to arrest decline and increase the production by improving the field's oil recovery factor. The redevelopment project was in two phases; the first began in 2000 and finished in 2006. In 2009, phase two (MHN project) began. This redevelopment was required to reinstate BHN production facilities that were destroyed in a July 2005 fire.

The MHN Process Platform Project and MHN Process Gas Compressor Modules Project was awarded to Larsen & Toubro (L&T) by ONGC on 31 July 2009 on an EPIC basis. Project scope included surveys, engineering, procurement, fabrication, transportation, installation, hookup, and commissioning of the process platform. It included oil & gas processing facilities, living quarters platform, and two flare platforms, all connected by bridges. The new platforms were also to be bridge-connected to the existing MNW platform. The new facilities along with the existing facilities of NA, NF and MNW are now known as the MHN process complex.

The MHN Project had many firsts including: the largest offshore process platform – MNP Deck (24,000 tonnes), largest living quarters in the Indian offshore (150 men), heaviest lift offshore India – MLQ LQ module (4000 tonnes), and longest bridge – MNP-MNF2 bridge (137m).

Project management

Project management of this magnitude demanded coordination between all disciplines, ensuring deliverables from various disciplines/departments as per requirements and pre-set targets. The challenge for the project management team was to ensure

MHN Process platform: major system capacities.

Sr No	System	Capacity	Specifications	Remarks
1	Well fluid handling	2,700,000b/d	-	HP & LP Separators
2	Oil handling	47,750b/d	1% BS&W	MOL pumps
3	Gas compression	6.9mmscm/d	7.5 to 97kg/sq cmg	3 trains
4	Gas dehydration	8.8mmscm/d	7 lbH_2O/mmcm	TEG based
5	Sour gas sweetening	1.7mmscm/d	Reduce H_2S to 40ppm from 2000ppm	MDEA based
6	Produced water conditioning	2,250,000b/d		
7	Living quarters (150 person)			
8	Utility systems to meet the process, safety and operational requirements			
9	Flare system for HP, LP and acid gas.			

healthy interaction between all disciplines. The team size and diverse locations added another dimension. The project clocked 17 million safe man-hours across disciplines and locations. The solutions were implemented and installation activities were completed before onset of monsoon in phase two.

Engineering

L&T Valdel Engineering (LTV) carried out engineering for MHN project. The main challenge was to execute design and engineering of the entire process platform complex that included FEED and detailed engineering. All the activities were to be performed concurrently with procurement and fabrication without affecting the overall project schedule and milestones, while meeting ONGC's stringent requirements. In addition, review and approval of engineering documents from Aker Engineering Malaysia and ONGC design team were also required.

To give a perspective of the structural challenge, the operating topsides weight of the MNP Process Platform was about 26,500 tonnes with a jacket launch weight of about 13,500 tonnes, while the living quarters topsides operating weight was about 8400 tonnes with a jacket lift weight of about 2260 tonnes.

Engineering faced many challenges during the MHN project. The jacket had to be delivered 12 months ahead of topsides. In addition the jacket design had to be adjusted to changes in topside weights (partly engineered). Normally, jackets are designed based on inputs for topsides. However in this project, engineers had to design jackets with limited data. The jacket design was updated and optimized based on inputs for topside weights.

Completing the launch jacket engineering within the available time was a daunting task, starting from conceptualizing the installation sequence, location, shape and size of buoyancy tanks, connection details, safety and integrity of jacket during installation, and a host of other parameters that had to be decided before finalizing the design. These activities required co-ordination amongst various disciplines and teams. The MLQ jacket weight and lift radius was reaching the capacity of the planned installation barge, *LTS 3000*, necessitating optimization of lift weight and design.

Living quarters weighing 4000 tonnes was optimized into in single piece collaboration with M/s Specialist Services. This was the first time such a large module and LQ was engineered.

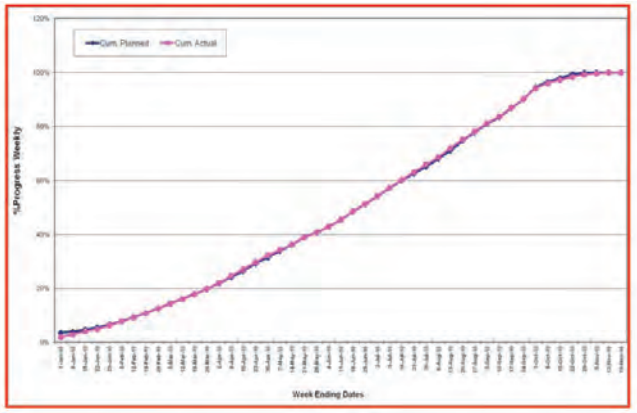
Due to the large weight of MNP platform and complex field layout, a floatover deck was not feasible. It was decided to fabricate the platform in 10 modules. The MNP deck included South East deck, South West deck, North deck, East deck and West deck. The MNP deck further supported five heavy modules: including building module, process gas compression (PGC) and one gas dehydration unit (GDU) – gas sweetening unit (GSU). To transfer this load to eight jacket legs, three heavy cantilever support frames were also required. The conceptual design of MNP platform was developed along with the installation contractor.

This construction was achieved by integration of basic and detailed engineering activities from L&T's multi-centered engineering teams with daily monitored project schedules and close coordination with external agencies and vendors along with the project management team.

Procurement

Mega projects require large quantities of materials including structural, piping, cables, equipment, and other items. Procurement scope included more than 300 equipments, 80,000 tonnes of structural steel, 50,000m of piping, more than 10,000 valves and pipe fittings, and 650km of cables. To ensure competitive prices and delivery schedules, the procurement team decided to source items from global vendors. Many of the packages were fabricated in-house and managed by the team.

Major packages were fabricated at MFF Hazira in order to meet delivery schedules and quality.



MNP jacket fabrication – planned *vs* actual.

This included the GDU & GSU package integrated into one module weighing 1700 tonnes. Other packages fabricated at Hazira included primary and secondary FG skids, and the produced water conditioning system package.

This was the first time that a GSU package was installed on an ONGC platform. This posed many challenges, first to prepare the functional specification, followed by approval of specific vendors. This was done by regular interaction with ONGC's Offshore Engineering Services.

Health, safety & environment

The HSE department ensured that all personnel were given safety induction before mobilization and after reaching the worksite. This included safety induction of subcontractor personnel, vendors, etc. This helped maintain safety standards and strict discipline at the project site.

Periodical HSE inspections were carried out by officers/engineers and line managers to ensure a safe working conditions. Any deficiencies found were rectified with top priority.

Fabrication

Fabrication was carried out in-house at Hazira and Oman and involved 13 million man-hours without any major loss time incident. At peak, more than 6000 personnel were working at MFF Hazira.

Apart from managing the workforce, managing material quantities was a large task involving quality requirements, storage, material tracking, and timely allocation. Action was required to procure small quantities of material on an urgent basis.

MNP jacket sail-out from MFY Oman.

MFY Oman

MNP jacket had all the complexity that an eight-legged jacket can have. The outside legs had double batter, whereas the inside (launch frame) was single batter, with 23 pre-installed risers on the jacket including one CRA clad riser, huge buoyancy tanks on side panels, and large sump caissons. The fabrication sequence was reviewed and optimized to arrive at the finally accepted sequence, which optimized resources and had the lowest fabrication cycle of 10.5 months.

Major changes in boat-landing design and a change from three to four steps were also accommodated during later fabrication stages. Mammoet was involved in skidded load-out of this jacket and the same was carried out smoothly. The extent of planning and execution of MNP jacket fabrication is shown above.

MFF Hazira

While L&T Oman was working to fabricate the MNP and MLQ jacket, MFF Hazira was also working to meet fabrication requirements. In 2010/11, MHN Project needed delivery of two flare jackets (750 tonnes each) and piles for all jackets (13,500 tonnes). In addition, the work had started on phase two structures for MHN Project (33,500 tonnes), MHN PGC Project (5000 tonnes), and MNW-NF Project (500 tonnes).

Quality assurance and inspection

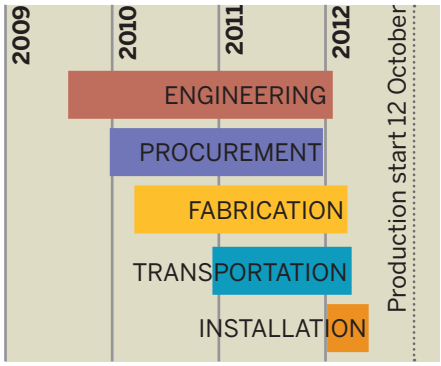
Apart from employing regular quality assurance and control, quality was also confirmed and emphasized by being proactive. Material and equipment were categorized based on criticality ratings. Representatives conducted inspections at every stage to ensure quality.

Innovation and adoption of new techniques was considered a key factor, providing leverage to the tight project schedule and commitment to continual

improvement. One of the major achievements was obtaining approval of phased-array ultrasonic testing (PAUT), in lieu of radiographic testing (RT) for structural and piping joints. Because there was no radiation hazard, work could progress in adjoining areas, resulting in improved productivity during fabrication at yard and hook-up offshore. A special RT technique called small controlled-area radiography (SCAR) was employed offshore during hook-up. This technique requires a much smaller safe radiation zone (1m). Hence, progress was enabled around the clock.

Special attention was paid on storage and preservation of E&I items and critical equipment by providing necessary materials, like vapor corrosion inhibitors pouches (VCI), VCI sheets, dehumidifiers, stretch films, *etc*. Inspection documents were strictly controlled. This helped clear inward material inspection reports, which in turn helped clear material for fabrication and lesser punch points.

A thorough control on minimized NDT backlog was achieved using electronic activity level planning system in yard, which enabled timely job completion and load-out with fewer fabrication punch points.



MHN Project time-scale.

Load-out

The Hazira yard has a tidal jetty. Load-out and sail-out operations are tide dependent and cannot be done throughout the fair weather season. Load-out and sail-out need tidal levels of 3.9-4.5m, and 4.7m, respectively. There are only a few available times that have the required tides for these operations.

Large modules require a large barge, which represented a further constraint. Transporting 400ft cargo barges through Hazira channel safely was difficult. Another challenge was posed by extra-long bridges (137m long) for the flare lines of MHN and MNW-NF

Load-out of MNP South East deck from MFF Hazira.

MLQ and GDU – GSU module installation in progress.

MNP platform during Level 1 integration.

projects, which had significant overhang.

The execution of the schedule concluded when the MNP-MNF2 bridge was successfully loaded-out on 29 February 2012, and sailed-out safely from Hazira channel on 7 March 2012. Forty-five barge movements were carried out in 3.5 months and used almost every available tidal slot. Jetty utilization was above 85%, setting a record.

During this work, many new records were set. The heaviest module load-out in India went to MNP South East deck at 4521 tonnes. A new record for the largest number of axles in one load out was 200 and was shared by MNP South East deck and MNP South West deck. While MNP East deck created the record for longest axle line in India with 44 axles and 70m in length.

Installation

After surmounting challenges of fabrication and load-out, installation of the modules was another large task. A total of 250 installation barge days were used for offshore installation. A total of 72 vessels were mobilized during the entire marine spread. Both phase one and phase two campaigns took more than 120 days each.

Phase one installation was performed by L&T's own installation group, formed in joint venture with Sapura Crest of Malaysia. The installation of the heaviest MNP jacket was smooth and without problem. Phase two installation was started by *DB-101*, which installed MNW-NF bridge, MNW crane, MLQ deck, MNF2 jacket, and OSV mooring buoy.

One challenge during installation was integration of Level 1 of MNP deck, comprising five splices and three cantilever supports. Precision work and fine tolerances were required for successful installation and integration.

The structural integration of modules into a single structure was required at each stage and significant time was taken in this integration. Integration of CSF frames with South East and South West modules took 12 days, after which East, North and West decks were installed. It took 11 days for integration of MNP platform's Level 1. However, after integration, the next five modules, three bridges, two cranes, and two flare stacks were installed. Installation was completed on 20 April 2012, and *Oleg Strashnov* sailed back after a successful campaign.

Hook-up and commissioning

After installation was completed, this left 25 days for hook-up before onset of the monsoon season and demobilization of the hook-up barges.

The MNP platform required a large number of splices and modules (10 modules and three cantilever frames) to be integrated offshore. Fifty percent of the cabling was to be done offshore and could not be started before installation completion. Cables had to run from MNW platform to MNP and MLQ platforms. Dry run and final commissioning occurred in parallel. Four barges worked simultaneously for installation and hook-up in the same complex.

The MLQ hook-up had a large GRE piping and plumbing scope. Hook-up work was started in parallel with installation. MNP platform hook-up work was started soon after installation of South East and South West deck. It was necessary to work in parallel with the installation. Additional safety measures and precautions were taken during the overlapping period. Simultaneous operations meetings were held regularly.

Due to the anchor patterns of the installation barge, the hook-up barge could not be connected to MNP platform using a gangway. The accommodation barge was anchored 2.5nm away from the platform from which passengers were ferried daily in crew boats. Software identified the spools and tracked the work. Software also helped managers make quick decisions without referring to the engineering center.

At peak, three hookup barges were used: *East Wind*, *Sea Stallion*, and *Sea Jaguar*, along with 850 construction personnel, including 750 workmen.

Substantial hook-up work was completed by 30 May 2012, before monsoon onset. Residual hook-up work, pre-commissioning, and commissioning of the MNP platform was completed with ONGC's support by accommodating manpower on the MNP platform and MLQ platform during monsoon.

The MHN process complex was commissioned and the platform started production in October 2012. The process complex was inaugurated on 21 October 2012 by CMD-ONGC. This complex will help in meeting growing oil and gas requirements.

The successful execution of MHN project was achieved by exemplary co-ordination between engineering, execution, construction, installation and commissioning. OE

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Devendra Awadhiya *is a chemical engineering graduate from Marathwada University. He is a chartered chemical engineer with more than 19 years of experience in process design and engineering. He has been responsible for process design, engineering, start-up, commissioning, process optimization, and trouble-shooting of on- and offshore process plants/platforms.*

Sandeep Badhe *is a mechanical engineering graduate from Mumbai University. He is project manager for MHN Process Platform Complex Project. He has more than 23 years of experience in project management, engineering, quality assurance, execution, and onshore/offshore construction of platforms.*

Rupchand Lohana *is a chemical engineering graduate from IIT, Mumbai. He has also completed an Executive MBA from SP Jain Institute. He is presently leading projects control discipline in Upstream Oil & Gas Projects. He has 14 years experience in process engineering, commissioning/troubleshooting, strategy, management, marketing, and business development.*

Offshore pipeline leak detection for Arctic applications

Dr **Premkumar Thodi**, **Mike Paulin**, **Duane DeGeer**, and **Glenn Lanan**, INTECSEA Canada, examine examine the potential of external distributed sensors using fiber-optic cable systems.

Multiple offshore Arctic fields have been developed over the past three decades, and the world demand for oil and gas will continue to drive development. The implementation of reliable Arctic operational strategies will allow additional offshore prospects to be developed.

Offshore pipeline technology is being advanced to accommodate Arctic challenges. Although arctic pipelines are designed not to leak, high-bending strains due to ground movements could result in leaks. Large leaks can easily be detected using computational pipeline monitoring (CPM) systems, but small leaks may go undetected, especially when the pipelines are located in remote environments or under seasonal ice cover. In these cases, external leak detection systems (LDS) can augment CPM for increased, overall leak detection reliability. However, there is limited documentation of successful external LDS performance offshore.

Leak detection challenges

Arctic offshore pipelines are subjected to many environmental loading conditions: ice gouging, strudel scour, frost heave, permafrost-thaw settlement, and wave/current loading if the pipelines are unburied. Potential failure mechanisms include fracture, burst, buckling, and fatigue. Trenching and burial are the principal design methods for protecting Arctic pipelines from environmental loading.

Arctic pipelines may be in remote locations and/or under seasonal ice cover. Thus, leaks must be minimized. An effective external LDS can mitigate leak-risk to human life, the environment, reputation, and financials.

Arctic pipeline leak detection challenges include:

- Buried pipelines conveying multiphase flows.
- Open water and seasonal ice cover.
- Installation and maintenance.
- Equipment and power.
- Operational management using supervisory control and data acquisition (SCADA).
- Remote performance monitoring and control.
- False alarms.
- Uncertain minimum detection thresholds.

- Background noise reduction.
- Operational reliability.

Considering the Arctic's environmental sensitivity, continuous leak monitoring may be preferred rather than periodic leak testing. Installation of continuous leak monitoring systems may help operators in permit application and regulatory review. Rapid and reliable leak detection and location identification are important aspects for safe arctic hydrocarbon development.

Existing technologies

LDS technologies can be classified into: internal or external systems (*Figure 1*). Internal systems use field sensor data to monitor internal pipeline parameters: pressure, temperature, viscosity, density, flow rate, contamination, sonic velocity, and product data at interface locations. Usually, these systems are installed along with the pipeline and other data acquisition systems. The data acquired are analyzed to determine flow conditions and potential loss. The systems quickly detect large leaks, but have limited ability to detect small, chronic leaks. Internal leak monitoring system methods include pressure/flow monitoring, acoustic pressure wave analysis, mass balance (MB), pressure balance (PB), statistical methods, real-time transient monitoring (RTTM), extended RTTM, bubble emission method, pressure safety low (PSL) switches, and annulus monitoring in pipe-in-pipe systems.

External systems measure physical properties around the pipelines. These include sensors for vapors, capacitance, temperature-differentials, biosystem, remote detection, acoustic, fluorescence, optical, and fiber-optic cables (FOC) methods. Some types are used as point sensors and others are mounted on ROVs/AUVs/towed systems to patrol for leakage. A recent development is to deploy a sensor array or continuous FOC along the pipeline length (*see panel, right*). >

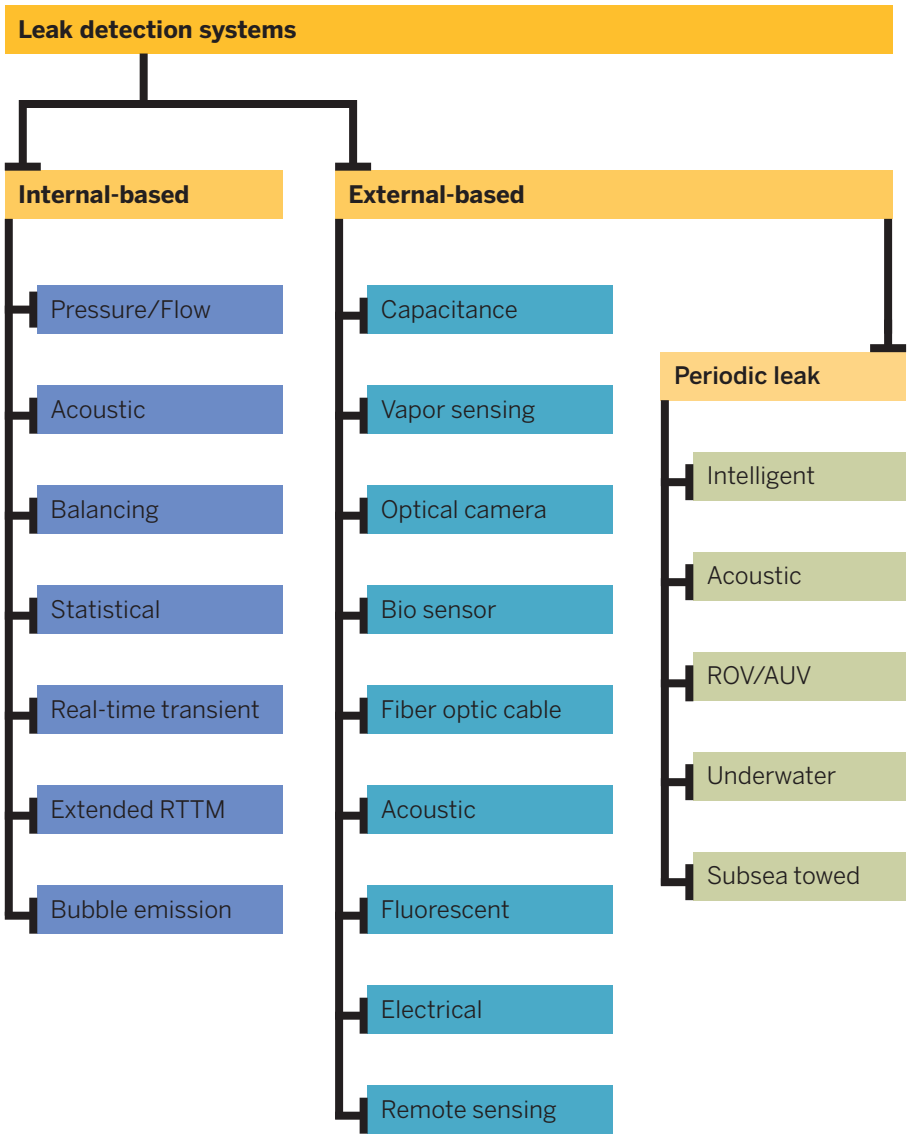

Figure 1. Leak detection technologies.

External leak-detection sensors include:

Vapor These detect leaks by a change in component resistance within the sensor chamber due to absorbed hydrocarbons.

Capacitance These detect leaks by measuring a change in the dielectric constant of the medium between two capacitive plates, when hydrocarbons contact them.

Temperature Differential Leaks are identified by measuring the temperature difference between the surrounding seawater/soil and any leaking fluid.

Biosystem These detect leaks by measuring the heart rhythm and frequency of opening and closing of clams, seeded and grown on the pipeline.

Remote detection Aerial or satellite images can detect an oil slick on the water using an infrared camera or radar.

Acoustic Hydrophones capture the acoustic emissions generated by leaking hydrocarbon.

Fluorescence/Optical Direct visual surveillance of the pipeline using video or still camera to locate leaks.

Fiber optic cable FOC sensors detect and locate leakage by measuring temperature and acoustic anomalies around pipelines.

Other external LDS are intelligent pigging, acoustic pigging, pipeline surveillance with ROV/AUV, underwater gliders, and towed systems. These are used for periodic leak detection or when a leak is suspected.

Internal LDS are well-established for detecting large leaks. However, sensitivity drops during operations that introduce pressure/flow variations (*eg* startup, shut-in, valve closures, transient flow, *etc*). These events can be misinterpreted, leading to false alarms. Such systems can be integrated into a pipeline's SCADA to record all large leaks (typically, above 1% of nominal flow rate). Systems usually detect large leaks in 30 seconds and small leaks within 24 hours.

External LDS can quickly detect and locate small leaks below the minimum thresholds of internal LDS, and provide information for risk mitigation. Depending on the technology, some external LDSs have limitations including:

- Regular repair/replacement for fouling and drift.
- Poor sensitive to smaller leaks.
- Dependence on ocean current/ diffusion.
- Difficulty in quantifying size and location of small leaks.
- Requiring permanent installation.
- Requiring leaking fluid-sensor contact.
- Requiring differential pressures.
- False alarms.
- Installation and maintenance difficulties.

FOC sensors overcome most of these limitations by detecting and locating leaks along a continuous optical fiber. Multiple leak events can be detected and accurately located. FOC has minimal external power or communication requirements, no pressure differential requirements, and is immune to electrical interference.[1] Other advantages of FOC systems include high sensitivity, accurate leak-location in all pipeline conditions, reduced false alarms, and applicability for continuous monitoring on long buried pipelines.

FOC distributed sensors

FOC distributed sensors have high potential for use in arctic pipelines. Liquid hydrocarbon leakage generates a local change in temperature that can be captured by distributed temperature sensing (DTS) systems with good spatial and temporal resolution. Similarly, the sound signature generated by leaking hydrocarbon can be measured using distributed acoustic sensing (DAS) systems. Inelastic Raman and Brillouin backscattering principles are used in DTS, whereas the Rayleigh backscattering principle is used in DAS (*Figure 2*).

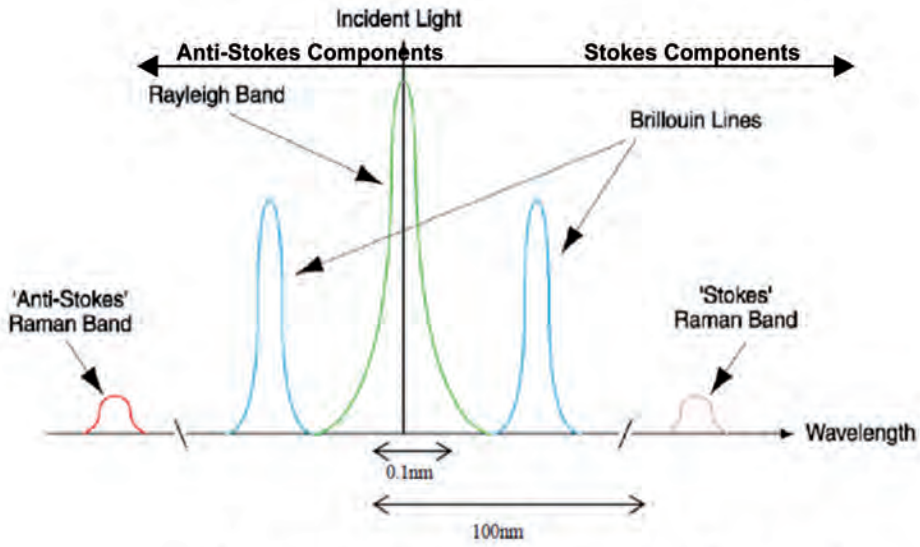

Figure 2. Fiber optic cable systems use different parts of the wave spectrum.[2]

FOC distributed sensing theory

FOC installed along the pipeline can measure thermal and acoustic anomalies in real-time. This continuous placement replaces multiple sensors along the pipeline and provides backscattered signal at the source after sensing anomalies. By analyzing the backscattered signature, leak presence and location can be identified to alert the control room.

In FOC distributed sensing, the optical time-domain reflectometer (OTDR) principle finds leaks (*Figure 3*). An optical signal is emitted into the fiber; a sensor receives and measures the light backscattered to the source. The received signal shows an exponential decay with time from attenuation. The time interval between the emission and backscattered detection can be easily converted to distance to the leak.

Distributed temperature sensing

An oil leak produces local environmental warming, while a gas leak produces local cooling from the Joules-Thompson effect. DTS can be based on inelastic Raman or Brillouin scattering (*Figure 2*). In Raman systems, thermally-activated vibrational modes result in spontaneous inelastic light-scattering, following Bose-Einstein statistics.[4] The information about the leak-generated temperature at any point along the fiber can be obtained by measuring the light-signal powers scattered at the anti-Stokes and Stokes wavelengths, and by evaluating the ratio between these two powers.

Raman-based systems require some filtering to isolate the relevant frequency components. Since the magnitude of spontaneous Raman scattered light is low, high numerical aperture multimode fibers can maximize the guided intensity of backscattered light.[3] However, the high attenuation of the fibers limits the length of Raman systems of 8-10km.[3,4] The FOC must be installed in an axial strain-free condition. Communications to surface can be through an existing subsea control module (SCM) incorporated into SCADA. Typical

spatial resolution is of the order of one meter and temperature resolution is 0.2°C.[3]

Distributed acoustic sensing

DAS uses a monitoring instrument at one end of the pipeline and two or more fibers within a FOC bundle to detect leakage. The FOC acts as a distributed hydrophone system that picks up sound from leakage. When a leak's sound signature is detected, location information is sent and an alarm is triggered. OTDR in the Rayleigh band monitors acoustic signals. The backscattered signals, measured as a time function, detect and locate leakage.

Rayleigh-based DAS systems have monitoring capabilities up to 25-50km without repeaters with a single instrument at one end of the pipeline.[2] Communications to surface can go through an existing SCM or by an acoustic link in SCADA. The DAS system may have a limiting threshold because of background noise. However, DAS does not require the cable to contact leaking fluid, and thus it may be promising for Arctic pipelines. DAS sensitivity to detecting a small, chronic leak will be affected by spatial resolution, coverage length, leak size/strength, background noise, acoustic signature, soil conditions, cable positions, distance from leak, and internal *vs* external pressures.

Installation and maintenance

DTS and DAS have both installation and maintenance challenges. In both cases the FOC must be close to the pipeline. They are typically supplied as subsea armored cables with diameters ranging 22-35mm. The cable can be bundled with, or laid adjacent to, the pipeline.

The pipeline may shield an acoustic signal from a DAS cable on the opposite side from the leak. Therefore, more than one cable may be required for optimum DAS detection. DAS systems for monitoring buried pipelines may be affected by trench and soil conditions. While some soil may transmit sounds better, others may insulate the FOC from sound, or reflect signal back to the leak. Installation and maintenance of the repeater/instrumentation units for a trenched pipeline may need further investigation.

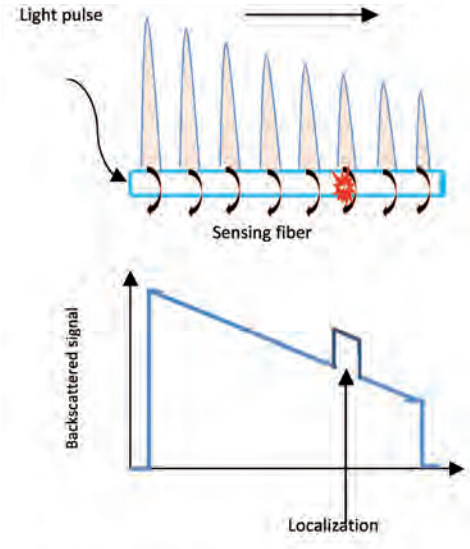

Figure 3. Optical time-domain reflectometers measure changes in backscattered light.[4]

Oil, gas, and multiphase fluids are typically lighter than seawater, thus the optimum position for a single DTS cable will be on top of the pipeline. However, the pipeline may rotate during installation, so having more than one cable for DTS provides optimum coverage.

Pipelines with sensing cables must pass over rollers on installation vessels, subsea trenching equipment, or onshore roller equipment for on-ice installation in the Arctic. The cables must be protected from crushing or snagging on the rollers. Winter or late open-water season installation temperatures may be below the minimum-rated installation temperature for FOC (–10°C). This limit may require heating the cable during unspooling and installation.

The laybarge needs reconfiguration for simultaneous installation of cables and pipeline making modifications for equipment attachment, reels, cable handling, and cable heating. Splices and connections introduce signal losses that affect the maximum coverage length for the system. Therefore, cable connections onshore, in-water cable splices, and those at offshore facilities should be limited by maximizing the cable reel size.

Technology gaps

Key technology gaps associated with the FOC-based, Arctic, offshore pipeline, leak detection include: uncertain minimum detection thresholds, false alarm reduction, FOC on long pipelines, reliability quantification, installation, and maintenance.

Arctic pipelines are designed to safely transport hydrocarbons, but low-probability leaks pose severe environmental, safety, and economic consequences. Online leak monitoring is an important aspect of safe Arctic pipeline operation to minimize any release. Since internal LDS's have limited capabilities to detect and locate leaks under 1% of the fluid flow, external LDS technologies may be warranted. OE

References

1.DNV-RP-F302 (2010). *Selection and Use of Subsea Leak Detection Systems*. DNV, Norway.
2.Eisler, B. & Lanan, G. (2012). *Fiber Optic Leak Detection Systems for Subsea Pipelines*. OTC 203070-PP, US, 30 April-3 May 2012.
3.Glisic, B. & Inaudi, D. (2007). *Fiber Optic Methods for Structural Health Monitoring*. John Wiley & Sons, UK.
4.Thevenaz, L. (2011). *Advanced Fiber Optics – Concepts and Technology*. CRC Press, US.

Dr **Premkumar Thodi** *is an engineering specialist with INTECSEA Canada. Dr Thodi gained his PhD degree at the Memorial University of Newfoundland, Canada. He has more than six years of experience in offshore pipeline engineering, pipeline leak detection, and integrity management.*

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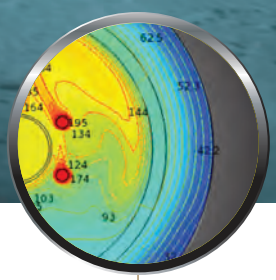

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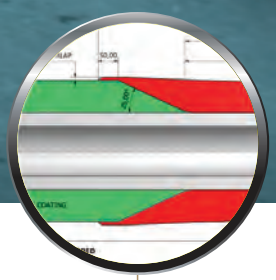

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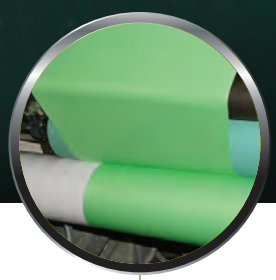


Pipe Coating Application ▶

Field Joint Coating

Subsea UK CEO Neil Gordon (*top right*) and Apache North Sea project manager Mark Richardson (*bottom right*).

UK subsea sector looks to increase global market share

Subsea UK's flagship event – Subsea 2013 – was held in Aberdeen last month. Subsea UK represents the UK subsea industry, which generates £6 billion in revenues, one-third of the global market, and supports 50,000 jobs. The industry body has over 250 members from the entire supply chain across the UK. **Meg Chesshyre** took a look at the buoyant state of the industry.

In his opening address, Subsea UK CEO Neil Gordon said that the global subsea market was set to double from £20 to 40 billion over the next five years. The big challenge for Subsea UK and for the subsea UK industry was how to retain one-third of that market and grow its global share.

He identified four global subsea hubs: the UK/European one; US/Gulf of Mexico; Brazil and the South Americas; then Malaysia, Singapore, Australasia and Australia. He pointed out that in countries like Brazil, Norway and the US had very strong government supported schemes investing in their technology. He called for similar support in the UK to help develop technology and to compete on an international level.

In Brazil there was an R&D tax incentive scheme where 1% of gross revenues from oil and gas went into a fund for research and development, with 50% being spent on education and 50% on technology. That fund has grown dramatically. "I think up until 2012 it accumulated £362 million, and by 2020 it is going to accumulate £6 billion." BG, for example, had located its centre of technology globally in Brazil. In the US, about $30 million is invested annually on technology development and in Norway about $14.5 million.

On the UKCS, the main focus was looking at maximizing oil recovery, which currently averaged 40%, compared with over 50% in Norway. Another challenge is the UK's ageing infra-structure. Integrity management, looking after the systems, was becoming a big focus for the future.

Significant growth

A survey of Subsea UK members, announced at the conference, revealed that 100% of firms are predicting significant growth in the next 12 months. Almost half expect to grow by 30% and a third by more than 50%. Almost 90% of those surveyed saw turnover and profits rise in 2012 with over half reporting growth of 20% and a fifth reporting more than 50% growth.

The key drivers for growth were identified as a sustained high

oil price, an increase in global demand and the introduction of new technology and innovation which are leading to more developments becoming viable. The fastest growing segments in subsea are inspection, repair and maintenance, integrity and reliability, decommissioning and offshore wind.

Gordon commented: "Subsea continues to be the unrecognised jewel in the crown of British industry. The sector is one of, if not the, fastest growing in the country and these findings will come as no surprise to the oil & gas industry as whole. Several respondents anticipate growing by over 75% in 2013 and many of our small, entrepreneurial companies focused on niche products and services are set to double or treble in size."

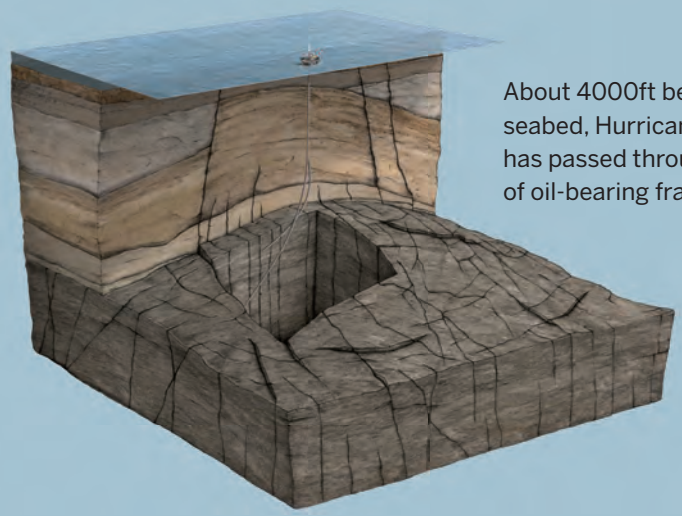
The biggest challenge facing the sector is recruiting and retaining skilled people with 88% citing this as their foremost constraint. Other challenges reported by 15% or more respondents were access to finance and working capital in particular, finding suitable premises, controlling costs and managing growth.

The main international markets for UK subsea companies are Norway, Brazil, US, Southeast Asia, Australia, West Africa, and the Middle East. Respondents were asked to rank their overseas markets in order of priority. Norway came out top with 25% of those surveyed indicating it was their first focus over the next few years, followed by the US (24%) and then Brazil (20%). Less than 12% said that the UK North Sea was a priority.

"This underlines the increasing importance of overseas markets," added Gordon. "Well over 50% of UK subsea output is already exported and that is set to increase."

Apache's success story

Apache's success story on the UKCS was spelt out at the conference by Apache North Sea project group manager, Mark Richardson. He



About 4000ft below the seabed, Hurricane's drilling has passed through a number of oil-bearing fractures.

The challenge of the Lancaster basement reservoir

EPC Offshore has just completed a reference case for a phased development approach for Hurricane Oil's Lancaster field, in UK block 205/21a, West of Shetland, to demonstrate that it is commercially viable, and the project is about to enter the next stage of its development. EPC Offshore CEO Keith Wallace discussed some of the challenges and the possible ways forward at the Subsea UK meeting.

The Lancaster field is one of the biggest discoveries in the UKCS in recent years. Containing an estimated 200 million barrels of recoverable oil, with a further 200 million barrels of 2C contingent resources identified in operator Hurricane's nearby Whirlwind asset, it has the potential to be a key strategic resource for the UK, but as a fracture basement reservoir it poses particular challenges.

Hurricane Exploration was created in 2005 with the vision and purpose of finding oil in fractured basement reservoirs – a first for this approach in the UK.

Wallace explained that EPC has been working with Hurricane on Lancaster for about 20 months. "What we've been doing is going through the concept selection process and that's really looking at all the viable solutions that could be deployed West of Shetland to develop the field fully, and what kind of investment that would require for each viable solution."

He said that there were a number of challenges on basement oil at this stage. The first thing was really being able to be confident that the wells were full consistently, and, therefore, how many wells were needed so a phase development approach was adopted. One of the schemes involves a small, new DP FPSO, which would have to be pretty robust because of the West of Shetland environment. This could drill one or two wells initially to prove productivity prior to the full field development.

"This small DP FPSO doesn't exist today, so we've been working with a contractor on a solution." The DP FPSO concept is not a commonly used solution; there has really only been one so far, the *Seillean*, used by BP as its SWOPS vessel, and now in Brazil. Due to the severe weather conditions West of Shetland it can only produce up to 75% of the time, although it has to be paid for all of the time. Another option is an initial tie-back prior to full field development to gain an understanding of the first couple of wells. Various other scenarios are also under review.

The next stage is to bring in a rig to drill a further well to do more testing. Hurricane has secured one rig slot this year and two slots next, subject to obtaining further funding.

Wallace is pleased with the way the project has gone so far: "EPC Offshore's skill sets are all really geared around the facilities that you would deploy into each scenario to make it happen. Hurricane's expertise is around basement oil reservoirs, exploration, the mechanisms, the modelling. So the two parties complement each other very well, in the thought processes, in the trying how to de-clutter this, and get to a solution that can be commercially backed."

Basement reservoirs

Basement reservoirs have been exploited for decades. However, since the mid-1990s, there has been increasing interest following major discoveries in Vietnam and Yemen, combined with the creation of new downhole tools, seismic technics and improved drilling technologies; and the higher oil price which has made basement projects more economically viable.

The best known basement reservoir examples are offshore Vietnam, where the Cuu Long Basin (*pictured above*) comprises 95% of the country's hydrocarbon production and 85% of this comes from the fracture granitic basement. Other significant discoveries have been made in the Yemen and Argentina's Cuyo and Neuquen fields. Beyond this, producing basement reservoirs have been explored in around 30 countries worldwide including Alaska, Canada, Chile, China, Egypt, former Soviet Union countries, India, and Greenland.

Basement reservoirs are a subset of naturally fractured reservoirs and owe their hydrocarbon storage capacity and productivity to the presence of naturally permeable fractures. The fractures have developed through a variety of geological processes and are so distributed that they provide a connected network of void space. The rocks hosting such fractures are typically igneous and metamorphic rock such as granite, basalt and gneiss.

Fractured basement reservoirs are typically associated with structures which, over time, have been uplifted in relation to the source (sedimentary) rock such that hydrocarbons are able to migrate into the basement fractures. The oil is not found in the rock itself, but in the faults and fractures between.

said that when Apache bought the property from BP in 2003, remaining reserves were put at 140 million bbl. Since then Apache has produced 200 million bbl with another 130 million bbl still to go.

Apache has spent about $3.5 billion upgrading the facility, drilling around 122 new wells, and the Bacchus subsea tie-back. A new satellite platform is being installed at Forties Alpha. The topsides go in this May, the same year that, under the original decline curve, Forties was due to be decommissioned. Operational efficiency has increased from around 65-70% to the high 90s. Lifting costs are running at around $10-$11/bbl, compared with an industry norm of around $18, and up to the high $20s for partner-operated fields.

A couple of years ago Apache acquired the Beryl area fields. "We see an opportunity to develop that field further and to do another Forties in terms of increasing production and extending field life", noted Richardson. A project to develop Beryl has just been set up and he can already see two big opportunities, which will either be large subsea tie-backs or new platforms on both the Beryl East flank and in the Nevis area – potentially a Beryl Charlie and a Beryl Delta.

He said that Apache had set a target for growth for the North Sea of between 6% and 7% annually over the next three years. Apache was looking to explore greenfield opportunities as well as tie-back to its host platforms, and had acquired more licenses than any other operator in the 27th UK licensing round.

He said that Apache had a very flat structure with 5500 employees worldwide, yet it produces 800,000b/d, about one-third of BP's production. "We are very small and flat, and we like to keep that accountability, responsibility and decision making down to the grass roots, to the people that understand the risk and understand the opportunities."

He acknowledged that the industry faced a problem with a small talent pool leading to crazy remuneration in some areas. One solution was to look outside the industry to areas such as the military, who are losing highly qualified and capable technicians, leaders, and managers. Apache itself was in the process of taking on 14 ex-military personnel for training as production technicians.

Richardson also stressed the importance of local content. "We need to be spending money with UK companies. Don't look to China and the Far East and other regions of the globe. Look locally first as to where you can procure things." Apache is just putting in a satellite jacket which it had built in Newcastle. "We revamped and revitalised the yard, took a company that was in administration. We

worked it through and actually we've got a major development employing 1200 people and 75% of the spend of that project has been straight into the UK."

New group launch

A new subsea oil and gas group, Harkand, chaired by oil & gas industry veteran Tom Ehret, was launched at Subsea 2013. Following investment by Oaktree Capital Management in Iremis, Integrated Subsea Services (ISS) and its sister company Andrews Survey last year, the three names have merged to form one group focused on the fast-growing subsea inspection, repair and maintenance (IRM) market. The new group has an ambition to grow to be the number one global IRM contractor with a turnover of $1 billion and a fleet of 20 vessels in the next five years. There are plans for major acquisitions to expand the global footprint very specifically in the near future, and for further investment in vessels.

The group will combine proven survey, inspection, repair, and maintenance services with the Iremis fleet of multi-purpose diving support vessels, ROV and air diving support vessels, and ISS's fleet of 23 remotely operated vehicles and teams of ROV operators, surveyors, and divers. The vessel fleet includes the new state-of-the-art multi-purpose diving support vessels *Harkand Atlantis* (*pictured left*) and *Harkand Da Vinci*. The group's name, Harkand, comes from medieval Arabic literature where it is the name of one of the seven seas.

Nicolas Mouté is CEO of the Harkand Group. International operations are headed by Harkand Iremis MD Patrick Chapalain and European operations are headed by Harkand ISS MD David Kerr.

Oaktree purchased Gulmar Offshore, rebranded as Iremis, last year. Its assets included two new DSVs, the *Atlantis* and the *Da Vinci,* built in Korea. *Atlantis* worked for Petrobras initially. This was followed by an investment in ISS and its subsidiary Andrew Survey. Oaktree then had both the vessels and all the services – diving, ROV, engineering project management, survey services, and inspection management. The *Harkand Atlantis* has now relocated to the North Sea and has an IRM program with Taqa this summer. *Harkand Da Vinci* is currently in West Africa and will shortly relocate for a new work program.

Harkand ISS has secured the *Relume* and *Loch Roag* ROVSVs on long-term charters to support its expansion in the subsea IRM market. The DP2 multi-purpose vessels will both be equipped with a Triton XLX heavy-duty work class ROV and an inspection class Mohican vehicle. They will also have full survey suites on board and optional air diving spreads. Both vessels have been chartered by ISS previously.

From its bases in Aberdeen, Dubai, Singapore, and Perth, the group is already carrying out work in the North Sea, Brazil, West Africa, India, Russia and the Caspian, Australia, Vietnam, and the Gulf of Mexico.

Harkand ISS managing director, David Kerr, commented: "The important thing is that we understand what our client really needs, and to go that little bit further in delivering that service, to give a competitive edge. What differentiates us from the competition is really being client focussed." He said that IRM was all about cost maintenance, using technology to save money. IRM had a hugely important role to play in the maintenance of the North Sea's ageing infrastructure, thus enabling the development of the remaining reserves as subsea tiebacks.

The client would be able to choose the most cost effective solution out of a full range of solutions. For instance, the recent use of smaller platform-based ROVs with special equipment on board had saved money on member inspection. OE

Subsea UK 2013 Awards

EPC Offshore won subsea company of the year at Subsea UK's seventh annual award ceremony held in Aberdeen during Subsea 2013. Photographed below is Keith Wallace, EPC Offshore's CEO with the award, accompanied by Carole Innes, business development manager at Brewin Dolphin, sponsors of the award.

The award for emerging talent was won by subsea engineer Paul Otway of Jee. Subsea Technologies was awarded the new enterprise award. The innovation and technology award went to CDL. The global exports award went to JDR Cable Systems. Hydratight picked up the safety leadership award.

This year's outstanding contribution award went to Mark Patterson, CEO of Nautronix.

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Gorgon module loading at Avenza, Italy.

'Power of one' to generate growth

GE Oil & Gas 2013 Annual Meeting, in its 14th consecutive year, was attended by more than 1000 oil and gas industry executives from over 70 countries. **Meg Chesshyre** joined the multitude in Florence, Italy.

At the beginning of the two-day event, GE Oil & Gas CEO Daniel Heintzelman highlighted significant industry mega-trends. About 80 million boe of new production capacity will be needed by 2020. There will be a five-fold increase in capital expenditure per barrel of new capacity added between 2008 and 2016. The industrial internet will add $90 billion in value to industry through increased recovery and production, and reduced capital and operating expenditures. Heintzelman said that around 50% of today's engineers would be eligible to retire by 2015. There would be a 9% growth in unconventional industry spend between 2012 and 2015, and a 14% growth in subsea industry spend. He added that the company will double its technology spend in the oil and gas segment over the next three years.

He stressed the importance of what GE chairman and CEO Jeff Immelt calls the "power of one." GE believes that a 1% improvement in a number of different areas can have a really big impact on customers' productivity. Of course, there are areas of the business that are growing faster than others – subsea, unconventionals in North America. The combination of industry growth and soon-to-retire professionals means that the competition for talent remains very strong.

Rod Christie, president and CEO subsea systems with GE Oil & Gas, agrees that the pace of project activity is increasing in the subsea sphere. It was much stronger in 2012 than in 2011. "There was a substantial increase in commercial activity in 2012. We can see that continuing through 2013. Not only is it new installation, but we are starting see more brownfield redevelopment,

GE Skills Development Center, Jandakot, Australia.

a number of enquiries around field expansion, additional add-on wells." One example is Balder 3 for ExxonMobil in the Norwegian sector, where the company is adding six more wells, as well as refurbishing and upgrading the controls.

Christie said that Angola had been very busy in 2012, in terms of deployment. The formation of a new joint venture, GE-GLS Oil & Gas Angola, was announced at the conference. As part of the agreement, the companies are planning an initial investment of $175 million to build a new manufacturing facility in Soyo, in Angola's Zaire province, that will supply subsea equipment to the oil & gas industry in Angola. The new manufacturing facility will start operating in two years. GE committed to recruiting and training Angolans for the project and a fairly extensive hiring program is now under way. Projects coming up in Angola include Chevron's Lianzi and a second phase of ExxonMobil's Kizomba satellites.

Christie also saw a continued high level of activity in Western Australia. There are clearly mega projects out there now – Chevron Gorgon, Inpex Ichtys, and a smaller project – Apache Julimar – awarded last year. In Australia, the challenge is to find human resources to staff the projects. To help overcome this problem, GE established a learning center last year at Jandakot, near Perth, on the same site as its service center set up the previous year. "This allows us do training and development for our own people and for our customers."

GE is investing in new facilities worldwide. Last year, it opened a $40 million extension to its substantial service facility in Macae, Brazil. A two-phase redevelopment is under way at the company's Bridge of Don facility in Scotland. An expansion to its machine shop in Montrose, Scotland, will open shortly, allowing it to build and test master valve blocks. Also in the UK, there is ongoing investment in Nailsea and a new projects office has been opened in Bristol.

Technology updates

GE Oil & Gas, which currently employs around 37,000 people in more than 100 countries, expects to continue growing. It had US$15.2 billion in revenues in 2012, and carried out over 90 product launches. Technology solutions announced at the show included GE Oil & Gas's Artificial Lift business-first motor cooling system, designed to meet the challenges of deeper wells and hotter environments. The system provides lower motor temperatures and employs a unique design that helps remove certain pressure and size constraints, making it easier to install. The Artificial Lift business

also launched a new, higher-efficiency electric submersible motor that simplifies installation. Currently in final field trials in North America, the new motor is designed to deliver more power and higher efficiencies than existing motors. With its overall length

Virtual flow metering enters reality

Dean Arnison, subsea controls business leader at GE Oil & Gas subsea systems group, revealed that GE as a group is working on virtual flow metering with a field specific package developed last year being installed by an operator ready for first gas in mid-2013. For its virtual flow measurement capability GE is moving towards commercialisation later this year with a generic version of the field-specific pilot installation.

Virtual flow metering is a method of calculating the flow rates through a system based on the existing instrumentation, knowledge of the facility and the properties of the fluid. This is made possible with the use of correlations that relate the flow rate to the pressure and temperature drop through the system. Although in some instances virtual flow metering can be considered as an alternative to physical metering it is often applied more successfully as a complementary technology – where the different measurement principles of each method can be used to cross-correlate actual and predicted flows to improve the overall accuracy.

Virtual flow measurement has an attraction in that the prediction solution is relatively insensitive to the loss of one or two physical measurements across a multi-well field. In other high integrity industry sectors such high availability systems are described as having 'graceful degradation' properties.

"Our strategy is to go-to-market as One GE, building on the strength and expertise of our unique solutions and product portfolio positioning to

Gorgon tree shipment, Aberdeen, UK.

reduced, it also should be simpler to install.

GE Oil & Gas launched its first single-shaft integrated compressor line (ICL), designed for designed for low-pressure ratio applications such as pipeline compression. Combining GE Oil & Gas compressor technology and GE Power Conversion motors and drive systems, the technology delivers energy savings, reduces emissions and offers easy remote control monitoring. Featuring up to 20% more operating range flexibility and greater efficiency, the new ICL costs about the same as conventional compressors.

GE Oil & Gas and Houston-based Sharewell Energy Services have signed an agreement that gives GE exclusive worldwide rights to sell Sharewell's proprietary electromagnetic telemetry technology as part of GE's measurement-while-drilling (MWD) portfolio. GE says the technology from Sharewell improves operating efficiencies by offering telemetry rates six times greater than conventional mud pulse-based MWD systems.

GE has received a contract to supply four complete, variable-frequency drive, high-speed electric motor and centrifugal compressor packages for Total E&P Norge's new offshore production platform on the Martin Linge oil and gas field. This is the first application of GE's high-speed, direct-drive motor-compressor package offshore. The packages combine GE Oil & Gas's centrifugal compressor technology on active magnetic bearings with GE Power Conversion high-frequency, variable-speed drive and high-speed motor technology. In addition, one of the packages has a unique configuration, with a central high-speed electrical motor driving one centrifugal compressor from one end and a two-section compressor from the other end.

GE's Blue-C compressor is now in the final phase of qualification


GE engineers at Nailsea, UK.

develop leading subsea electrical and power solutions for the oil and gas industry," Arnison explained.

"With that technical frame, at subsea controls business we have the opportunity to develop a batch of Smart applications which add value to the operation of a subsea multi-well field.

"These applications leverage GE's research capabilities together with our applications experience drawn from other industry sectors as diverse as aerospace and wind energy. Each Smart application requires a model of the dynamics – typically of fluid flow, of a mechanical mechanism, or of electrical flow – through subsea located hardware."

Experience and detailed knowledge of the equipment design (the domain competence of a subsea systems tier one supplier such as GE Oil & Gas) and the ability to perform multi-variable optimisation calculations allows GE to build such models. GE is at the early stages of piloting these technologies, leading to a tangible demonstration of the 'value add' proposition, one example being virtual flow metering.

testing and has accumulated more than 2300 running hours while installed in a pool at the Nyhamma plant in Norway. Blue-C has been built in a fully marine version for the Ormen Lange Subsea Compression Station Project, executed by Aker Subsea for Statoil and Norske Shell. It is designed for unattended operation more than 2950ft below sea level, with power up to 12.5MW. Installation on the seabed is expected in 2019. It will have a five-year maintenance cycle.

Another recent award is a contract worth more than $500 million to supply turbomachinery equipment and services to Petrobras (*OE* February, page 83). The contract will serve the four new floating production, storage, and offloading units (FPSOs *P-74*, *P-75*, *P-76,* and *P-77*) in the Cessão Onerosa region of the Santos Basin pre-salt fields, in the state of São Paulo. The scope of supply, which also takes in technology from other GE businesses, such as power conversion and power & water, includes: 16 powergen turbogenerators composed of PGT25+ gas turbines and electric generators, eight turbocompression trains driven by LM2500+ gas turbines and 32 electric motor driven compressors for gas main, export services and CO_2 re-injection. In addition to core equipment, the new contract includes technical assistance for installation and commissioning start-up and services, such as repair, dedicated local field service engineers and customer training.

Multiphase flow

Multiphase flow and multiphase pumping are areas where GE Oil & Gas continues to focus, said Christie. "For everyone in this space, as we go deeper into harsher environments, the question becomes – what is the service interval? How many times do you have to intervene, how easy is it to recover." He thinks there will be ongoing activity in that area for a number of years until coatings technology and pumping technology have reached acceptable levels.

GE Macae, Brazil.

One of the advantages that GE has is bringing together the core competence in sensing and diagnostics from its measurement and control division with the subsea systems division's subsea production expertise, interfacing the measurement and control multiphase team with subsea control and trees team. One of the issues to be addressed is ongoing accuracy, with the surface application being ahead of the subsea application in this respect.

Brian Palmer, GE's VP of measurement and control, said that one of the company's biggest investments going forward is being directed to solving multi-phase flow measurement. "It is a tough problem, and one that GE is well suited to solve, because we can draw from our research and development centre. We can draw from our health care business with our ultra sound and MRI capability. We are not there yet, but we are very optimistic that we will get there."

GE Nailsea, UK.

He added that GE was piloting some land-based multiphase flow that had proved successful so far in accurately determining sand, water, oil and gas out of land-based wells, instead of tank testing the wells. It saved a lot of time, a lot investment in test equipment, but more importantly it was more accurate.

Another example of leveraging data acquired by sensor and devices from a platform, had been to expand it to all equipment on an operating platform, then instead of having the equipment expert sitting on the platform, bringing the data back to an engineering environment. With the addition of different platforms and multiple assets it was possible to compare fleets enabling real monitoring diagnostics. The value so far has been the ability to predict potential failures, so that a crew can be mobilized for a scheduled outage rather than a forced one, with the parts on hand.

Palmer said GE was very focused on thinking about how to drive instrumentation into subsea operations. Last summer, it acquired Naxys, a provider of subsea leak detection and condition monitoring sensors based on passive acoustic technology, headquartered in Bergen. OE

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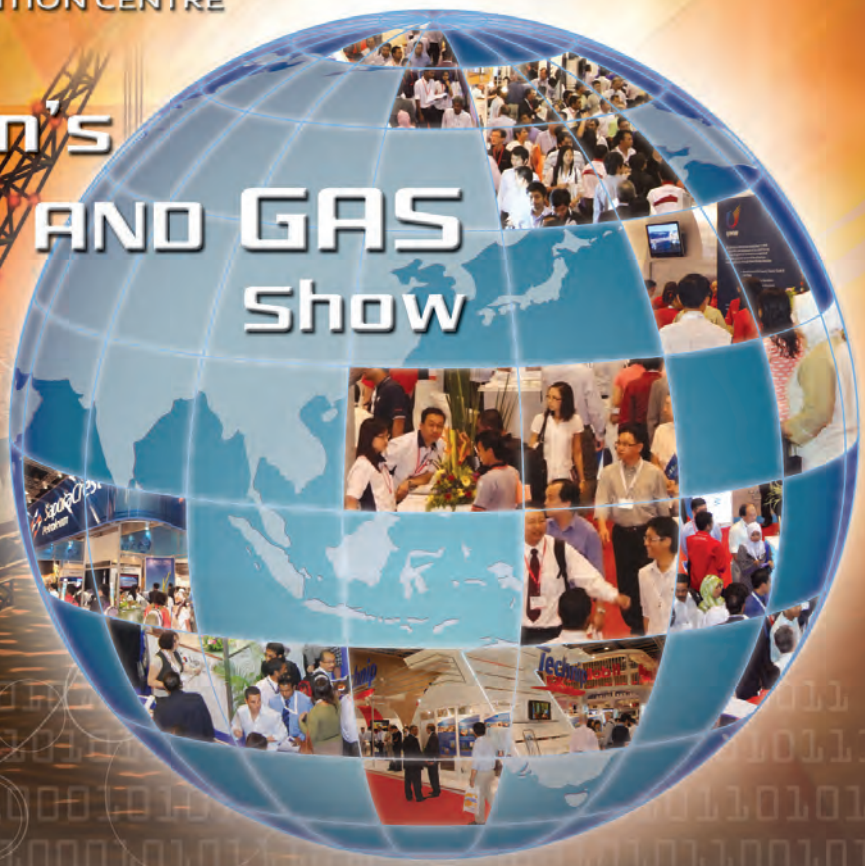

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Mediterranean activity rebounds after unsettled 2012

Oilfield activity in the Mediterranean region was disrupted by extreme political events last year across northern Africa. The 'Arab Spring' revolutions in Egypt, Libya, and Tunisia, as well as the continuing conflict in Syria shut down most non-essential activity. With offshore operations slowed or delayed in the southern half of the sea, the industry has continued operations mainly in the east with modest activity across the northern Mediterranean.

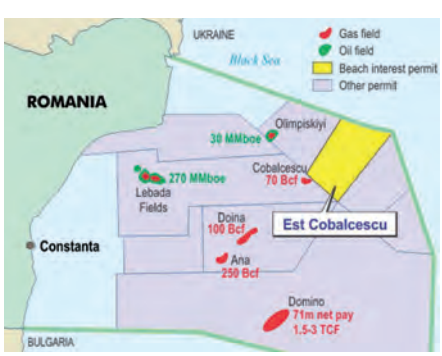
Activity has been greatest in the Black Sea where companies are seeking new reserves around established fields, and linking Russian gas reserves to southern Europe through the construction of the South Stream pipeline, a sister system to the earlier completed Blue Stream pipeline that was completed in 2002.

Black Sea

The merger of Petroceltic International and Edinburgh-based Melrose Resources was completed in October 2012, with Melrose as the successor. The merged company says that the integration process has gone smoothly. Last year, Melrose gathered reservoir data over the Galata field (shut-in) off Bulgaria and determined that it holds at least 6bcf of natural gas reserves.

Melrose finished interpreting 3D seismic data it acquired last year over the Galata block (1790 sq km, 691 sq mile). The company has identified seven structures with P50 reserves (unrisked) of 125bcf (3.5bcm). It plans to drill two wells this year and four wells next year to test targets. The most prospective structure, Kamchia, estimated at 27bcf. The Kamchia-1 well is scheduled to spud in April.

Melrose plans to drill one well on each of its (formerly Petroceltic) Romanian concessions, Est Cobalcescu and Muridava. Older 2D seismic revealed Cretaceous and Eocene oil plays along with Miocene and Pliocene gas plays. Reserves are estimated to be 1-2tcf.



Last year, South Australia-based Beach Energy acquired a 30% interest in Est Cobalcescu. The 1000 sq km area lies in less than 100m (328ft) water depths and contains proven hydrocarbon plays and multiple exploration play types. Beach holds two consecutive three-year licenses, the first of which is compulsory. The company has the right to extend the term an additional four years. A year ago, ExxonMobil announced a 3tcf discovery at its Domino-1 well on adjacent acreage.

According to Beach, the western Black Sea had several periods of strike-slip deformation and inversion during the Palaeogene. The Middle Miocene section is characterized by subsidence with carbonate platforms separated by deeps. This was followed by compression during the Pliocene that formed large anticlinal structures. The shelf has at least two different petroleum systems. The Mesozoic system has an oil-rich source, likely Early Cretaceous, which charged Mesozoic and Eocene limestones and sandstones.

The Pontian dry gas system is found in deltaic sands. Some of this biogenic gas is from Pontian shales, with some Oligocene thermogenic gas also charging the sands.

Romania-based Midia Resources discovered gas in its Eugenia-1 well drilled to 2276m TD in the Pelican block (2312 sq km) off Romania. The well penetrated two gas reservoirs, totaling 22m net pay, in Late Cretaceous sandstone from 1938-2038m MD. Porosities ranged 10-20% and gas saturations ranged 55-62%. An Eocene limestone section had gas shows.

Midia is a wholly-owned subsidiary of Sterling Resources (65% WI). It is the operator of the Midia and Pelican blocks with partners Hungary-based Petro Ventures Europe (20%) and Netherlands-based Gas Plus International (15%). In addition, Midia has gained Romanian government approval to buy 50% interest in block 25 (Luceafarul), which covers 1000 sq km. Petro Ventures will retain 50% in the block. In an independent evaluation, RPS Energy estimated Luceafarul's potential reserves at 104bcf (2.9bcm).

Romania-based OMV Petrom (operator) and ExxonMobil (deepwater farm-in of 50%) are shooting a 6000 sq km, 3D program over the Neptun block in the Romanian Black Sea. The 1600 sq km shallow-water survey is being shot by CGG Veritas with the *Oceanic Champion*'s eight-streamer array.

Eastern Mediterranean

The Levant Basin, between Republic of Cyprus and the Mediterranean's east coast, has produced multiple natural gas discoveries since 2009 including: Tamar (10tcf), Dalit (0.5tcf), Leviathan (16tcf), Cyprus (5tcf), Tanin (1.2tcf), Dolphin (0.6tcf), and Shimshon (2.3tcf), for a total discovered reserve base of 35.6tcf. Noble Energy continues a drilling program in the basin using the *ENSCO 5006* semisubmersible.

These recent discoveries have accelerated infrastructure development in the eastern Mediterranean. US-based Radius Oceanic Communications and the Cyprus Telecommunications Authority (Cyta) launched the Poseidon project, a high-capacity undersea cable system intended to provide advanced telecommunications facilities to the offshore oil & gas industry in the region.

The system will extend for 800km from two shore landings in Cyprus, creating a ring that borders the Cypriot Exclusive Economic Zone (EEZ), enveloping the offshore oil and gas lease blocks established for development. Cyta provides landing facilities and collocation services at its cable stations in Pentaskhinos and Yeroskipos. Through the system, Radius will offer managed broadband services on a subscriber basis to offshore exploration, production and support facilities

in the EEZ. Through Cyta's telecommunications hub, Radius says it will be able to provide its offshore customers with secure, low-latency, broadband connections to key locations worldwide.

Cyprus' second offshore licensing round was completed in May 2012. Officials announced winners starting in January. Eni and South Korea-based Korea Gas Corp (Kogas) in consortium won blocks 2, 3, and 9 in the deepwater portion of the Levant Basin, which covers 15,530 sq km. Eni will operate with 80% interest.

Total was awarded two

production sharing contracts (PSC) for blocks 10 and 11. The licenses extend over 2572 sq km and 2958 sq km respectively, southwest of Cyprus, in water depths from 1000-2500m. The company will begin acquiring 3D seismic over block 11 and 2D seismic over block 10; each program targets a different play.

Most recently, Israel-based Delek Drilling and Avner Oil Exploration signed a PSC with Cyprus for exploration rights, appraisal, development, and production in block 12. With the signing, Noble retains 70% interest in the block, while Delek and Avner each hold 15%.

Israel

Toronto-based Adira Energy is exploring three licenses off Israel that have significant potential: Gabriella (110mmbo), Samuel (66mmbo), and Yitzhak (79mmbo), but is having issues with its partners. Recently, it suspended operations on the Gabriella license due to lack of funds. Adira is designated operator of that license with 15% WI. Its partners include Israel's Modi'in Energy (70%), Canada's Brownstone Energy (15%), and Israel's Tohar Hashemesh Energy (5%).

The Gabriella license is about 10km northwest of Tel Aviv and covers 392 sq km in water depths from 100-425m. Last year, Netherland, Sewell & Associates estimated up to 110mmbbl of unrisked oil on the license.

Egypt

In January, Aberdeen-based Dana Petroleum received approval from the Egyptian government to further develop the Nefertiti oil field in the Gulf of Suez following a successful appraisal well.

Dana, in partnership with Japan-based Inpex, successfully drilled the Nefertiti-2X exploration well at the end of 2012. The well tested at a maximum stabilized flow of 1850b/d using an electrical

Pipelines

Last year, Turkey approved construction of the South Stream pipeline through its territory, which will bring Russian gas across the southern Black Sea and into Europe. Construction should be completed in 2015, with the offshore component costing US$13 billion. The largest stakeholder is Gazprom (50%), followed by Eni (20%); EDF and Wintershall each hold 15% of the project. Construction of the eastern section through Bulgaria's offshore territory is scheduled to begin in June and be completed by 2017.

SOUTH STREAM PROJECT

The Trans-Adriatic Pipeline (TAP) will transport gas from the Caspian region through Greece and Albania, then across the Adriatic Sea into southern Italy where it will connect into western Europe. The project is aimed at enhancing supply security, as well as supply diversification for European markets by expanding delivery capacity from 10bcm to 20bcm per year. TAP will open a new 'southern gas corridor' to Europe and establish a new market outlet for Caspian natural gas. The designers also plan to include the ability to physically reverse up to 80% of the flow to ensure security of supply during any operational interruption. Shareholders include Switzerland-based Axpo Group (42.5%), Statoil (42.5%) and Germany's E.ON Ruhrgas (15%).

TAP and E.ON New Build & Technology (ENT) are engineering the onshore segment of the project, and have implemented a two-staged pre-qualification for steel pipe suppliers. TAP will require 400,000 tonnes of steel pipe to lay about 800km of 48in pipeline over a three-year construction period. In 2015, TAP contractors will begin connecting the Shah Deniz II gas field off Azerbaijan to European markets. First gas is expected to flow by the end of 2018.

The governments of Albania, Greece, and Italy recently demonstrated their commitment to TAP by signing a tri-lateral intergovernmental agreement (IGA). The IGA solidified the countries' commitments to the development, construction, and operation of TAP. Within the framework of the Community Treaties and the Energy Community Treaty, the IGA ensures that the states cooperate in the timely delivery and efficient operation of the pipeline.

SOUTH STREAM PROJECT

submersible pump. The field is expected to produce 2500b/d when it comes onstream later this summer.

Italy

Italy's government lifted its offshore exploration and production moratorium after ratifying Legislative Decree 83/2012 last August, opening its formerly closed territory within 12 nautical miles of the coast to renewed activity. The decree also raises prior royalty rates by 3%, increasing them to 7% for oil and 10% for natural gas production. The increase will fund marine environmental protection and safety for offshore operations.

Ireland-based Petroceltic International was affected by the drilling ban as operator of the B.R.268.RG permit (126.68 sq km, 31,302 acre) in the Adriatic Sea. Its Elsa discovery on the shallow-water block is estimated to hold 100mmbo and 31.5bcf of gas.

Calgary-based Cygam Energy had two exploration projects that were affected by the decree, BR268RG permit (30% partner in Elsa) and CR148VG permit (336.98 sq km), off Sicily, the company's Aretusa prospect. The Sicilian license expired during the moratorium, but its term was extended to November.

Mediterranean Oil & Gas (MOG) will now be able to seek a production concession for its Ombrina Mare field in BR269GC permit. The Adriatic Sea field is estimated to hold 40mmbo and 6.5bcf of gas.

ENSCO

Noble Energy continues its drilling program in the Levant Basin using the *ENSCO 5006* semisubmersible.

Malta

Last December, the government of Malta awarded three offshore blocks totaling 6400 sq km to Capricorn Malta, a subsidiary of Edinburgh-based Cairn Energy. Cairn CEO Simon Thomson is looking to balance the company's portfolio of frontier exploration assets. Capricorn Malta will conduct a study, acquire additional data, and assess the exploration potential of the acreage under an exploration study agreement.

The offshore areas granted are blocks 1, 2, and 3 of Area 3, located north of Malta. The term of the exploration study agreement is two years and requires Capricorn to invest at least US$2.5 million on exploration operations. The work program consists mainly of the reprocessing of existing 2D seismic data, the acquisition and processing of a minimum of 1500km of new, 2D seismic data and technical studies.

MOG was granted a one-year extension (to January 2014) for Offshore Area 4 by the government of Malta. An evaluation of the block identified four prospective structures: Hagar Qim, Tarxien, Skorba, and Dalam at the Eocene/Palaeocene level. The Hagar Quim structure has mean unrisked reserves of 109mmbo in the El Garcia formation, which MOG plans to test in 4Q 2013 by drilling the Hagar Qim 1 well. AGR Well Management will provide engineering and rig procurement support.

This year, activity should begin to recover in northern Africa as new governments stabilize. New opportunities in the Adriatic will be stimulated by Italy's return to normal offshore operations, as well as by the new pipelines being built from the east.

Most significantly, the Levant Basin will see growing investment as companies work to develop the world-class discoveries found in recent years.

Victor Schmidt

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Solutions

SPOTLIGHT

Hybrid propulsion systems to be installed

DNV and the Norwegian shipping industry partnered to develop battery-powered vessels. Four hybrids, powered by a mix of battery and diesel-electric propulsion, will hit the water this year and next. Eidesvik Offshore's supply ship *Viking Lady* will be the first to have a battery package installed this spring. "Hybrid ships are similar to the well-known hybrid cars, like the Toyota Prius," said Remi Eriksen, CEO of DNV Maritime and Oil & Gas. "A major advantage of these ships is that the payback time on additional investments is expected to be two to four years compared to more than 10 years for cars."
www.eidesvik.no

Thermal treatment process

UK-based integrated drilling and environmental solution provider TWMA offers thermal processing technologies designed to treat oil mud contaminated by drilling wastes at the source. The thermal treatment process uses a cylindrical mill to convert mechanical energy into thermal energy; causing liquids to flash evaporate from solids without an external heat source. Rock powder is then discharged for disposal or reuse. TWMA is expanding its offshore TCC Rotomill service to truck-mounted systems for land-based projects.
www.twma.co.uk

Vessel range extended

Netherlands-based IHC Merwede introduced a new series of IHC Packhorse offshore support vessels last month. The vessels range from the Packhorse, a PSV, and the Packhorse-Maxi, which provides a 59-person accommodation unit, and options designed for subsea support on IRM work, light construction and cablelay projects. The new OSVs will be built through an agreement with IHC and Jaya Holdings.
www.ihcmerwede.com

Simulation software

CM Labs Simulations launched a new simulation and visualization software called Vortex, designed to reduce cost and risks during offshore operations. It's suitable for in engineering, testing, planning, and training.

Vortex software can be used to simulate dynamics of virtual cranes, equipment, ROVs, AUVs, vessels, cable systems, tethers, and sonar.
www.vxsim.com

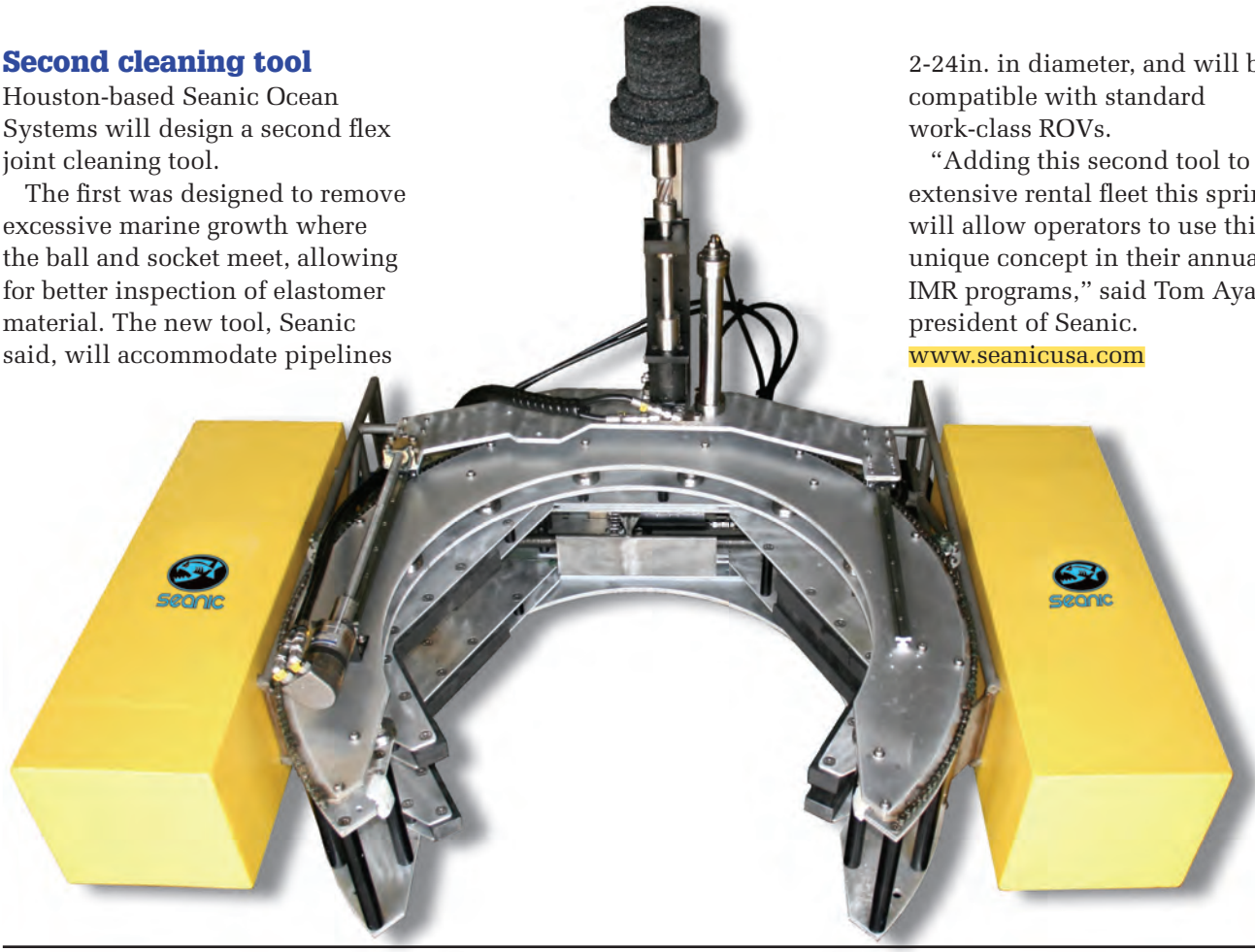
Second cleaning tool

Houston-based Seanic Ocean Systems will design a second flex joint cleaning tool.

The first was designed to remove excessive marine growth where the ball and socket meet, allowing for better inspection of elastomer material. The new tool, Seanic said, will accommodate pipelines 2-24in. in diameter, and will be compatible with standard work-class ROVs.

"Adding this second tool to our extensive rental fleet this spring will allow operators to use this unique concept in their annual IMR programs," said Tom Ayars, president of Seanic.

www.seanicusa.com



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Activity

Shell teamed up with Kinder Morgan's **Southern Liquefaction** to develop a natural gas liquefaction plant at Southern LNG's Elba Island terminal near Savannah, Georgia, US. The partners plan to modify the Elba Express Pipeline and the Elba Island LNG Terminal in order to transport natural gas to the terminal and to load the LNG onto ships for export. The total project is expected to produce 2.5mmtpa of LNG.

Subsea engineering firm **Jee** opened its first London office in January. The new location is part of the company's strategy to create 150 jobs in the UK over the next four years. "The new location will allow us to better serve existing clients, and will be a hub from which we can attract more high-caliber employees," said Mike Hawkins, technical director of the London office.

Aker Solutions acquired Aberdeen-based well control equipment firm **Enovate Systems** for an undisclosed amount. Aker plans to develop Enovate as an independent supplier of components and products that can be used for open water workover, riser workover, rigless intervention, and drilling safety systems. Enovate's current management will continue on with the company after the acquisition.

Spain's **Repsol** partnered with the Netherland's **Tocardo**, a tidal and free-flow water turbine producer, to develop offshore tidal energy. With backing from Repsol's New Energy Ventures business, Tocardo aims to enhance its offshore engineering capabilities.

Variable Bore Rams struck a deal to supply **Weatherford**'s Asia Pacific subsidiary with blowout preventer rams. Equipment stocking began last month and includes multiple sizes of rams. "We hope that our presence in the Asia Pacific region will help us to grow globally and increase our service offerings overseas," said Variable Bore Rams president Hines M Marshall Jr.

Aberdeen-based subsea marine equipment rental firm **Seatronics**, an Acteon company, completed the start-up phase of its new facility in Macaé, Rio de Janeiro. The center will serve as an office, workshop and warehouse facility for sales, rental, engineering, and cable molding activities. "Brazil is a vitally important area for our survey and ROV clients," said Fabio D'Agostino, Seatronic's new VP in Brazil. "The new facility will enhance our options for providing products and services to all our Brazilian and international customers."

Texas-based coiled-tubing provider **Global Tubing**, opened a new service center in Red Deer, Alberta, Canada, last month. The 1709 sq m facility will house two full indoor service lines, and provide coiled tubing services including spooling, welding, hydro-testing, preventative maintenance, asset management, repair and wireline injection services.

SPOTLIGHT

Houston warehouse boost

Dubai-based shipping, logistics, and marine services provider **GAC** began construction on its new North Houston office and warehouse. The 181,067 sq ft cross dock building, slated for completion in July, includes four acres of outside storage space. "We are excited about the opportunities this latest new warehouse will bring to the Houston community in terms of jobs and business from the oil and gas markets," said Bob Bandos, CEO, GAC Energy & Marine Services. Pictured at the recent ground-breaking ceremony are (*left to right*) GAC executives Carlos Arrieta, Bob Bandos, William Hill, and Lars Heisselberg, with Jay Kraft and Hans Brindley of Liberty Property Trust.

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ADV-017

On the Move

Audrey Leon

Life after ION

Following his departure from ION Geophysical, former president, CEO and executive chairman, **Bob Peebler** launched his own consultancy firm, The Peebler Group, in January. After 40 years in the industry, Peebler says the idea to start the new company came from his fascination with technology; in particular how to turn technology into a business, and his wanting to help others by sharing what he has learned through experience.

"I've always enjoyed that," he says. "Whether you're a small company in the growth stage or a big company trying to reinvent yourself, there first needs to be a strategy behind it, but even more important, how do you turn a strategy into being implemented successfully by a company?"

Peebler says he also hopes to help bridge the gap between companies and private equity firms.

"Probably 10-20% of the time private equity companies can easily identify the winners when they walk in the door with a business plan, and 50% of the time they aren't interested," Peebler says. "Then there is that 30% that peak the firm's interest, but they don't have time to make complete sense of the company's business plan.

"This is where we can help by doing more due diligence on the prospect company; including their technology and markets, and also help them further develop their business plan," he says.

Peebler would like to help technology and services companies operating in the upstream oil and gas business find the right growth plan. In turn, Peebler wants to help private equity firms secure the right investment, serving as a translator between the two entities so that both get what they need from a potential partnership.

Peebler expects the consultancy to be fully up and running within the next few months.

Subsea support

Houston-based offshore survey company UTEC appointed **Simon Hird** general manager of its Australian arm UTEC Survey Australia last month. Hird, an industry veteran, with 30 years experience in the oil and gas sectors, has been stationed in Australia since 2008.

Hird is a believer in the strength of the Australian offshore market. What attracted him to working with UTEC, he says, is the company's ability to provide support for it.

"[Australia] is dominated by a series of major subsea construction projects, viewed as some of the largest currently undertaken in the world," he says. "Coupled to this as a by-product of major construction is a rapidly increasing subsea infrastructure offshore Australia, all of which has to be safely operated and maintained for years to come.

"This provides UTEC with its next challenge – to position the company locally as the premier provider of through-life survey and inspection services. This will require slightly different skill sets and supports a different client base; UTEC is again well placed to support that particular market," Hird says.

Spreading the word

Aquatic Engineering & Construction, an Acteon company, named **Martyn Conroy** its new business development manager covering the Europe, Middle East and Africa regions. Conroy previously worked for Ashtead Technology, FirstSubsea and Hydratight.

Conroy has been traversing the globe spreading the word about Aquatic's offerings, which includes working with the customer to configure and tailor Aquatic equipment, such as tensioners and powered reel drive systems, to fit their specific project need.

"It's a company that's growing with the demand

of the market and our aim is to be the preferred partner for reeled products and services," Conroy says of what attracted him to his new position.

"It is a great opportunity for me as an ex-engineer to work for a true engineering company. Aquatic is first and foremost an installer of flexible product and has a track record second-to-none in engineering and delivering projects in-line with our customer's demands."

Conroy spent 12 years as an engineer, previously working as a design engineer for Expro Group, before moving into sales. Conroy says the move into sales is a more natural fit.

"I understood the principles of engineering; I liked engineering, but found my strength was exploring and understanding the customers' requirements and coming up with a commercially workable solution," Conroy says of his transition. "I like dealing with people and couldn't sit still behind a desk," he says light heartedly.

Leveraging big data

Energy consultants Knowledge Reservoir named **Dan Gualtieri** vice president of production solutions in January. Gualtieri previously worked with Baker Hughes, Halliburton, Boots & Coots and Weatherford International, where he touched upon all aspects of the oil field.

"Every two to three years I'd go into a new role focusing on projects in a different aspect of the well delivery process – stimulation diagnostics, wireline, digital asset solutions, intelligent completions, shale strategies, consulting, project management, and others," he says.

"Understanding an operator's needs and having a strong aptitude for project management allowed me to be of value to Knowledge Reservoir and apply what I had learned across the board."

Gualtieri says he's joining Knowledge Reservoir at an exciting time due to the company's focus on full field development strategies as well as the launch of new knowledge-sharing platforms that will allow it to leverage big data.

"The company has a strong knowledge sharing strategy, initiated with its release of the deepwater knowledge base, ReservoirKB, in 2003," Gualtieri says. "The subscription based service expands on public domain data with layers of independent interpretation and analysis."

This year Knowledge Reservoir will release two platforms dedicated to unconventional resources and enhanced oil recovery.

Editorial Index

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Numerology

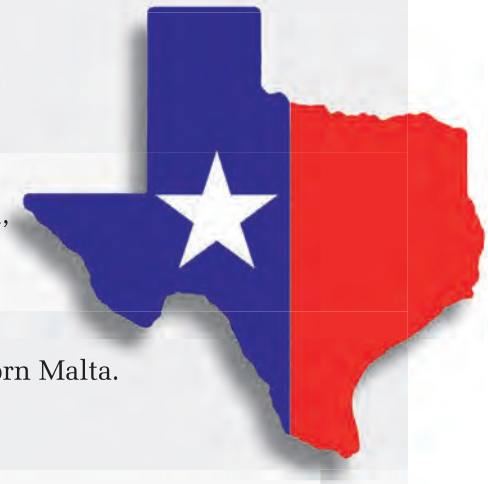
#1 Turkey has highest price for gasoline in the world, paying US$9.89/gal. *(Source: Bloomberg)* ▶ See 'Geographic Focus' on page 65.

2015 The year 50% of today's engineers are eligible to retire. ▶ See full story on page 59.

68% Expected rise in the number of producing subsea wells from 2013-17. ▶ See FMC story on page 28.

2188 Water depth, in meters, of the Sul de Tupi discovery area. *(Source: Petrobras)*

#14 Texas would be the 14th largest oil producing nation, if it was its own country. *(Source: ConocoPhillips)*



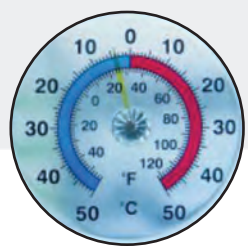
3 The number of blocks Malta awarded to Cairn subsidiary Capricorn Malta. *(Source: Cairn Energy)* ▶ See full story on page 65.

2400 Number of workers and engineers who helped to build the FPSO *Cidade de Itajai*. *(Source: TeeKay Corp)*

20 Oil-bearing strata, in meters, encountered at the DTM sidetrack well off Gabon. *(Source: Panoro Energy)*

3000 Ormen Lange reservoir lies approximately 3000m below sea level. *(Source: Shell)*

–10°C The minimum-rated installation temperature for cables. ▶ See full story on page 48.



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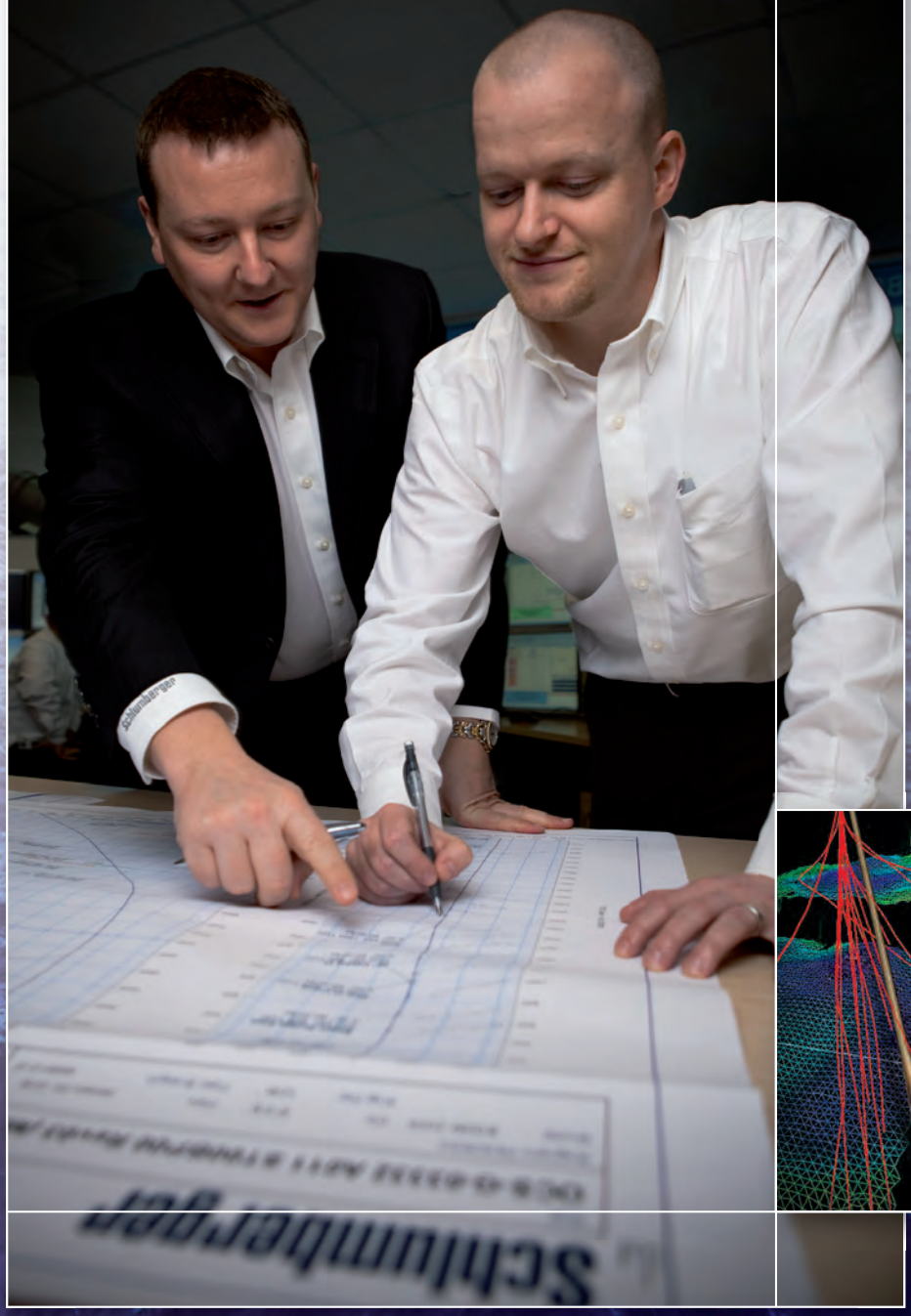

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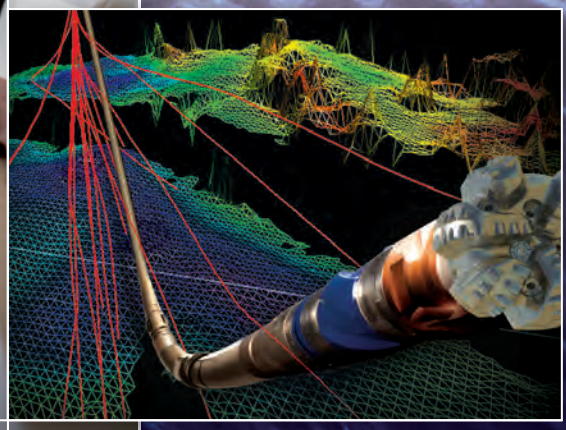
HIGH BUILD RATE RSS



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Read the case study at
slb.com/Archer

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