THE FIRST SPE NORWAY JOINT SECTIONS MAGAZINE
TO GATHER MEMBERS
TO SHARE KNOWLEDGE

Finance & Management
Reservoir Engineering
GeoExploration
Drilling
Renewables
BigData

Photo: AGR/Genel Energy/Noble
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**The First**

- **the SPE Norway Magazine**
  Vita V Kalashnikova
  vito@pss-geo.com

- **Electronic version is available on the SPE Norway sections websites**

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Many Are Already Standing On Your Broad And Innovative Offshore Shoulders And Now We Need You To Invent Offshore E&P2.0

Dear SPE Colleagues in Norway,

For 40+ years the NCS has demonstrated how offshore E&P can be done safely, sustainably, high-tech and in a highly commercial way in harsh and very demanding North Sea conditions. The incremental and disruptive technological advances and lessons learned that you have delivered to the industry have gallantly been shared with the rest of the global offshore and subsea world in SPE papers, at SPE conferences and at SPE Forums. For all this we salute you! And therefore, your ‘CV’ is our global heritage!

But Churchill said: ‘success is never final’ and Darwin: it is only those that adapt that will survive, and at $50/bbl and a ‘Rhapsody in C’s’ facing the industry (costs up, complexity up, competitiveness and profit margins down, communities expecting more, climate change a real issue, grew change speeding up,...), it is time to re-think what we do and how we do it and to re-base our cost level after sailing along for 4 years at $100/bbl where it seemed like we could afford anything and everything. Now, the buzz words in E&P are: we must not forget that we are manufacturing oil and gas, so we need a manufacturing mind-set: focus on the supply chain and the just-in-time inventory, industrialize, standardize and simplify, draw one - build many, start with the ‘minimum kit’, don’t gold-plate, reduce specifications … And, find a way to utilize the ‘internet of everything’, ‘big data’ to drive efficiency along with ‘integrated operations’ and semi-automated drilling (remember that IBM’s ‘Watson’ computer beat two Jeopardy champions so why should he not drill faster, smarter and safer?) thrown in.

Yes, I am talking about E&P2.0 on the NCS that you will help develop – with initiative, creativity and passion constantly ‘spying on’ and learning new tricks from other industries. In a way, with so many world’s first already from the NCS and a new one, subsea compression, coming in 2015, and with average recovery factors already so high that everybody else are envious, it is a hard act to follow your own act! But, you can and you will!

I am confident that the NCS will show the way again with brand new, perhaps risk-sharing business models between the actors, a cheap and safe ‘Legoland approach’ to field developments, with wells drilled 50% quicker with AI assistance, drilling unconventional 10,000 ft unconventional wells in conventional NCS fields with massive reliable down-hole pumps boosting production rates to amazing heights plus drones shooting seismic and new materials making everything in E&P much lighter and cheaper. Should I add 3-D printers printing well heads when you need them? Just like before, it will take heart, head and guts and a lot of collaboration. Collaboration is called ‘Darwin’s blind spot’; I think massive cross-discipline, cross company, company-company, E&P business-other business, …, collaboration will give us more value creating inflection points than anything else. The silver lining in a low oil price period is that the industry is forced to change and adapt to stay competitive. We have seen and mastered low oil prices before and as they say, ‘life starts at 50’ – so the NCS has good times coming … if you become NCS2.0!

Bottom lines: Thank you for being such a force for good. You get up every morning and help 7.3 billion people get their energy every day. We all love renewables, but solar, wind and bio-fuel only contribute with 2-3% of the global energy needs in 2015 and fossil fuels with ~80%. So while we R&D and Moore’s law (solar kWh price vs time) our way to not using oil in 85 years (in 2100?) the world will need oil and gas for several more generations of E&P professionals. And with gas substituting for coal in electricity generation, it looks like we can stay ~+2degC as well.

On a final note, Professor Th. van Golf-Racht, passed away in February 2015. He was a giant for years in the NCS reservoir engineering community and I want to honor him by saying: Thank You Professor for your massive contributions and for believing in us! And, peace over your memory! And we will never forget your advice: When you forecast, always try to be ‘wrong in the right direction’!

I wish you all only the best and thank you again for being an SPE member – we’re 143,000 non-profit members in 141 countries on a mission to share!

Dr. Helge Hove Haldorsen
Director General Statoil Mexico
2015 SPE President

Dr. Helge Hove Haldorsen holds the position of Director General Statoil Mexico in Mexico City after serving as Vice President Strategy & Portfolio Statoil North America in Houston, Texas. Prior to his tenure at Statoil, Haldorsen worked for North Hydris in various roles including Chief Reservoir Engineer, Vice President Technology and Computing, Vice President Exploration and Research, Senior Vice President International Exploration and Production, and President Hydro Gulf of Mexico.

Haldorsen has also held various engineering positions at British Petroleum, Standard Oil of Ohio (Sohio), and ExxonMobil in Anchorage, London, San Francisco, Stavanger and Houston. He was a Sounder Laureate in the Royal Norwegian Navy and Professor of Industrial Mathematics at the University of Oslo as well as a Lecturer at Sandpoint University in California. He has served on the Society of Petroleum Engineers’ Board of Directors for three years. He has also been an SPE Distinguished Lecturer and an SPE Distinguished Author. He has authored numerous technical papers and articles on reservoir engineering and other E&P topics.

Haldorsen earned an MS in Petroleum Engineering from the Norwegian Institute of Technology in Trondheim and a PhD in Reservoir Engineering from The University of Texas at Austin. He served on the Offshore Technology Conference Board of Directors for 5 years and currently serves on the IVT EC, All The New Big Things! Advisory Board and on the Executive! Advisory Board for the Gulf of Mexico Oil & Gas at The University of Texas at Austin. Dr. Haldorsen is the 2015 President of the Society of Petroleum Engineers (SPE), with 34,000 members in 139 countries and he writes his Presidential Column each month in the Journal of Petroleum Technology (JPT) – www.jpet.org/jpt. Haldorsen was awarded the 2013 Rockies Petroleum Industry Leadership Award by the American Society of Mechanical Engineers (ASME) – see https://people.fas.harvard.edu. Dr. Haldorsen was awarded the 2013 Rockies Petroleum Industry Leadership Award by the American Society of Mechanical Engineers (ASME) – see https://people.fas.harvard.edu.
The SPE is all about sharing knowledge and experience. This sharing happens in our events and through publications like this one, which I feel honoured to have been asked to contribute to.

In Norway we have 5 sections and 5 student chapters that cover the main oil and gas “locations” of the country. These entities are innovative and a clear example of this has been their events. Last February the SPE Oslo organised a seminar of Big Data, which is a critical topic for our industry to improve its profitability in the short and middle term. Another excellent example of quality service to SPE members is the SPE Bergen One day Seminar, an event that has been running for over 20 years and that recently became the first SPE paper event in Norway. These are just two examples of how local sections are a great platform for knowledge sharing and networking for SPE members and non-SPE members in Norway. The Board of Directors (BoD) of the SPE realise the importance of the Oil and Gas Industry in Norway and it is excited about the possibility to increase and improve its presence in the country. We are working hard to develop our existing events and to create new ones that could help us to achieve our mission that has two key elements: knowledge sharing and professional development. Since I joined the BoD as North Sea Director a bit less than two years ago I have been in Norway eight times with the clear purpose of better understanding our members’ expectations, discovering and discussing with the section about their activities; and trying to improve the way we operate in the country. Based on these visits I have been working with other volunteers on the establishment of a National Council in Norway covering the 5 sections (Stavanger, Bergen, Oslo, Northern Norway and Trondheim) with about 3000 professionals members and 700 student members overall. This council will focus on the coordination of the SPE activities at a national level and on the collaboration with SPE International. I am confident that this council would be a great contributor in building a roadmap for the SPE development in Norway for the next decade and I am looking forward to closely working with it.

These two years as North Sea Director have been a unique experience to meet great people, discover new places and to give back at least a slice of what I have received from other SPE volunteers. I thank all our members for your trust on the Society and want to express my gratitude to volunteers for your time and efforts in serving our members. It is an honour and a pleasure to work with you guys!

Sincerely
Dr. Carlos A. Chalbaud
SPE North Sea Director

News from SPE Ireland Section

The SPE Ireland section is the newest section in the North Sea region, having been established in August 2014. Our aim is to build an organisation which will help enhance our members careers in the oil industry by promoting networking and providing a forum for the exchange of technical ideas and information about the industry. Given the challenges the industry has seen since we formed our section, the SPE is more relevant than ever to help our members stay connected to the industry and to each other.

We held a social event soon after establishment, which was attended by over 40 of our members. This was followed by our inaugural Oil & Gas Industry Event in January 2015. This evening event was attended by over 130 delegates associated with the Irish oil and gas industry, and was a great showcase for our fledgling section.

The Irish Government Minister of State for Natural Resources, Joe McHugh, gave an opening address. SPE President Helge Hove Haldorsen gave an inspirational lecture on SPE’s role in the future of the oil and gas industry. Tony O’Reilly, CEO of Irish based explorer Providence Resources plc, discussed the status of hydrocarbon exploration offshore Ireland, whilst IHS Cera Vice President Paul Markwell gave a talk about the role of technology in the future of the industry. The event was made possible thanks to the support of our gold sponsor IHS. Photographs of our 2015 Oil & Gas Industry Event are available on our website photo gallery. We are currently looking forward to hosting the event again during 2016. Of course we would be delighted should any ‘The First’ readers be interested in attending or supporting the 2016 event.

Thanks to the support of the SPE International and our 2015 Distinguished Lecture Series sponsor Tullow Oil plc, the distinguished lecture series was brought to Ireland for the first time ever in February 2015 with a lecture from Jim Crafton on “Shale Well Performance Metrics”. Our second Distinguished Lecture is scheduled for 12th May 2015 with Terry Matthews delivering his talk “Diamond – A Drillers Best Friend”.

UCD Student Chapter
The Ireland section quickly formed links with one of Dublin’s major universities, University College Dublin (UCD), to support the formation of a Student Chapter. With graduate employment intake reduced this year as the industry responds to the macro oil price environment, it is more important than ever that we continue to provide the encouragement and support to our students whilst this industry cycle works itself out. To that end we are encouraged to be able to support the Student Chapter not only through section support with career talks and information, but also through the SPE International Student Scholarship Programme and the Enhanced Faculty Travel Programme. Additionally, the UCD Chapter is sending three keen student chapter members to the North Sea Regional Student Development Summit in Aberdeen which takes place in September 2015 coinciding with Offshore Europe. We look forward to continuing our support of the student chapter and to help it increase its links to the international oil and gas industry. If we could help them form new industry links to Norway that would be the icing on the cake for 2015!
January 2015 Event

Left to Right: Helge Hove Haldorsen (SPE President); Tony O’Reilly (CEO Providence Resources plc); Joe McHugh (Minister of State for Natural Resources); Paul Markwell (IHS Cera V/c President); Conor Ryan (SPE Ireland Programming Co-Chair); Carlos Chalbaud (SPE North Sea Regional Director); JJ Madudu (SPE Ireland Programming Co-Chair)

January 2015 Event

Paul Markwell (IHS Cera) presenting to the attendees

January 2015 Event

Attendees at the event

Follow the SPE Ireland Section
Web: http://connect.spe.org/ireland/home
LinkedIn: https://www.linkedin.com/groups/SPE-Ireland-Section-6759109
Email: spe-ireland@spemail.org

SPE Northern Norway

The 2015 SPE Workshop in Arctic Norway was held 11-12 March with 75 delegates attending. The presentations authorized to be published can be downloaded here:

http://www.speworkshop.no/presentations/

SPE Norway

Find your section!

SPE Northern Norway Section is delighted to congratulate Karl Ludvig Heskestad for winning SPE 2015 Regional Service Award! Congratulations on this outstanding achievement!

SPE Oslo Section is delighted to congratulate Karl Ludvig Heskestad for winning SPE 2015 Regional Service Award! Congratulations on this outstanding achievement!

The Society of Petroleum Engineers (SPE) is a professional association whose 85,000 members worldwide are engaged in energy research, development, and production. Local sections of the SPE are established around the world, all over the world. In Norway, there are five local sections. Each section maintains its own individual website, voice, and more!
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The energy sector on Oslo Børs has three main subsectors: Drilling, Oil service and Exploration & Production. The price of the companies has fallen steeply after the drop in oil price from USD 110 to 55 per barrel since July 2014. Investors now have access to world class companies and assets to low prices in a historical perspective. Consolidation, mergers and acquisitions is expected and Oslo Børs plays a key role.

Background: Companies move from private to public ownership through stock exchange listing when the owners can obtain a favorable pricing of their business in the market. A stock exchange listing allows the Company to raise capital to fund further business expansion and to make the shares of the company an acquisition currency for later deals. However the financial market, which is dynamic, is subject to takeovers from others with the same motive for growth that initiated the stock exchange listing in the first place. A takeover of a publicly traded company is a strictly regulated and concerns large amounts of money in exchange for transfers of ownership and control of valuable assets for many shareholders. The company holds the role as the Norwegian supervisory authority on takeovers and plays a key role when any company listed in Oslo is attempted acquired by another party.

Oslo Børs energy sector: The energy sector on Oslo Børs consists of three main subsectors: Drilling, Oil service and Exploration & Production (E&P). The market capitalization value of these sectors is obviously strongly correlated with the development in the underlying oil price, as illustrated in Graph 1. The group of E&P companies are internationally attractive with Statoil as the largest company with exploration and production activities. In total 14 E&P companies are listed in Oslo with a total market capitalisation of NOK 535 bn and together the companies have exploration and/or production activities on five continents. The energy sector is still the largest sector on Oslo Børs in terms of market capitalisation despite of the drop in oil price since July 2014 with correspondingly low share prices for energy companies. With an oil price of around USD 60 per barrel the total market capitalisation of Oslo Børs is only 1/3 relat-ed to the energy sector.

Table 1: Selection of targeted energy companies on Oslo Børs and Oslo Axes

<table>
<thead>
<tr>
<th>Company</th>
<th>Year</th>
<th>Industry</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoil E&amp;P</td>
<td>2013</td>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Rocksource</td>
<td>2014</td>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Bridge Energy</td>
<td>2015</td>
<td>Production</td>
<td></td>
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<tr>
<td>Fairstar</td>
<td>2015</td>
<td>Production</td>
<td></td>
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<tr>
<td>Aker Drilling</td>
<td>2015</td>
<td>Offshore Drilling</td>
<td></td>
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<tr>
<td>Scorpio Offshore</td>
<td>2015</td>
<td>Offshore Drilling</td>
<td></td>
</tr>
<tr>
<td>Flex LNG</td>
<td>2015</td>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Sevan Drilling</td>
<td>2015</td>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Reach Subsea</td>
<td>2015</td>
<td>Production</td>
<td></td>
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<tr>
<td>Reservoir</td>
<td>2015</td>
<td>Exploration</td>
<td>Technology</td>
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<tr>
<td>Technology</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Prospector Offshore</td>
<td>2015</td>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Fred Olsen</td>
<td>2015</td>
<td>Production</td>
<td></td>
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<tr>
<td>Asia Offshore</td>
<td>2015</td>
<td>Production</td>
<td></td>
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<tr>
<td>Dockwise</td>
<td>2015</td>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Discovery Offshore</td>
<td>2015</td>
<td>Production</td>
<td></td>
</tr>
</tbody>
</table>

Graph 1: OSE/BX, Brent Oil and Oslo Energy Drilling, E&P and Oilservice indices 2010 – 2015. All data downloadable from www.osloboer.no free of charge. When using the images the source must be credited.

1 The company subject to a takeover is normally referred to as “Target”.
2 EU takeover directive implemented in the Norwegian Securities Trading Act and Securities Trading regulation.
3 Securities Trading Act §6-13 for an exhaustive list of all content requirements.
The offer price should be at least as high as the highest payment subject to minimum requirements: mandatory bids the offer price is subject to voluntary bids. Also, in a mandatory bid the offer price is subject to minimum requirements. The offer price should be at least as high as the highest payment made or agreed to by the Offeror or its consolidated parties in the six months period prior to the point where the mandatory bid obligation was triggered. If it is clear that the market price at the point when the mandatory bid obligation is triggered the bid price should be as high as the market price. All mandatory offers are documented in separate Offer documents which are subject to approval by Oslo Børs. The offer document is normally prepared by the legal advisors of the Offeror and should reproduce the bid and give correct and complete information about matters of significance for evaluating the bid. The offer document is distributed to all shareholders in the Target, and is very important in the sense that it serves as the formal basis for the shareholders to accept or not accept the offer upon. Its content is subject to formal legislative requirements e.g. offer price, valuation, settlement and guarantees, conditions, financing of the offer and consequences for the employees.

Conclusion: The market conditions have changed dramatically for the global energy sector over the past year. This is also seen clearly in the energy sector in Oslo. Consequently the center of attention has gravitated from high listing activity towards anticipated high level of activity with consolidation and mergers and acquisitions. It is difficult to predict if the anticipated high consolidation and M&A activity will be realized. Regardless, takeovers are an integrated part of the financial market dynamic. This is also the case in Oslo where many attractive energy companies are listed. Oslo Børs plays a key role in this respect, both as the market place where the shares of the company are listed and as the Supervisory authority for takeovers for all companies subject to Norwegian takeover rules.

Visiting address: Tollbugata 2
Postal address: Box 460 Sentrum, 0105 Oslo
Phone: +47 22 34 17 00

Kanja Bah
Head of Division Petroleum and marine division
The Norwegian Industrial Property Office (NIPO)

Norwegian Industrial Property Office (NIPO) by Kanja Bah, Head of Division NIPO

Short on what NIPO is?
NIPO (Norwegian Industrial Property Office) is the Norwegian National Authority for the handling, processing and granting of applications on intellectual property rights, which is normally abbreviated as (IPR). Intellectual property is an umbrella term for all values a company owns, which is not of physical substance. A prime example is patents, trademarks and designs. NIPO is a government authority organized under the Ministry of Trade, Industry and Fisheries, and was established in 1911. NIPO has approximately 260 employees working with technology and science, legal issues, marketing services, public information on IPR, support and administration. NIPO is a partner in Nordic Patent Institute, and as such, acts as International Searching Authority for patent applications within the and even moving images that distinguishes your goods or services from others. Design: design concerns the shape and appearance of an article or part of a product. A design that also serves a technical function should be protected by patent, for example an outer construction of a ship hull that has dynamic functions on sea. Information services: We provide our customers with information on technological developments within a specific technical field, help to strengthen Norwegian trade and industry in various ways. We are a national centre for seminars and conferences. We provide knowledge and expertise concerning intellectual property rights. NIPOs value chain enables businesses to secure their investments, their competitive market position and as such generate economic growth in Norwegian society.

Products and services
As aforementioned, we process and grant applications on patent, and as a guide and within a specific technical field, we give prior assessments of patent cases (that is to say, provisional decisions). We also offer a wide variety of courses and seminars in both Norwegian and English.

Why should you bother?
A patent can give you an important competitive advantage because you will enjoy exclusive rights to use your invention commercially in a period of 20 years. During this time, you can prevent others from manufacturing, importing or selling the invention you have patented. A patent provides you with a sound basis for entering into sales and licensing agreements, if you do not want to produce and market your product yourself. In such cases, industry on technological developments within a specific technical field, and as such, act as International Searching Authority for patent applications within the PCT (Patent Cooperation Treaty) system. Nordic Patent Institute also carries out various patent searches and analysis for foreign companies.

Functions of the Norwegian Industrial Property Office (NIPO)
The primary role of the Norwegian Industrial Property Office (NIPO) is to promote innovation and value creation, both as national and international property rights authority, and as a guide and within a specific technical field, we give prior assessments of patent cases (that is to say, provisional decisions). We also offer a wide variety of courses and seminars in both Norwegian and English.

Patent resource heterogeneity
NIPOs knowledge base within IPR constitutes our greatest competitive advantage. The patent department in NIPO has four technical divisions comprising of 82 engineers within the fields of oil, gas, shipping, engineering, biotechnology, agriculture, organic and non-organic chemistry, mechanical engineering, electronics, physics, electricity and computer science. We have extensive experience with this expertise from 1911. In addition to our legal practitioners. In order for example an outer construction of a ship hull that has dynamic functions on sea. Information services: We provide our customers with information on technological developments within a specific technical field, and as such generate economic growth in Norwegian society.

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Norne 2030 – It ain't over till the fat lady sings
The Norne lifetime extension project aims to continue production beyond 2021

by Audun N. Nyre – Leader Norne Petech RR, Statoil ASA

The Norne field has been producing since 1997, and in the original plans Norne FPSO was scheduled for shut down in 2014. Since then, the licenses in the area have developed several satellite fields which are tied in to the Norne FPSO. The production license has been extended to 2021 and the recovery factor on Norne main field is steadily approaching 60%. Two important factors to ensure life-time extension beyond 2021 are: sufficient remaining reserves and technical integrity of the Norne FPSO.

Norne Main Field
The Norne main field is at the tail of its production. In Figure 1 the production estimate from the first year of production is plotted together with the numbers from the revised national budget (RNB 2015). The economical cut off was historically estimated to be in 2014. The main field is included in the plans for extending the Norne area life time, but without the satellite fields there would not be a sufficient volume base.

Satellites
The Norne FPSO is producing from four satellite developments in addition to the main field. Two oil and gas fields; Urd (2005) and Skuld (2013), and two gas/condensate fields Alve (2009) and Marulk (2012). These satellites have contributed to the prolonged production from the Norne FPSO. From Figure 2 we see that volumes equivalent to the original reserves of the Norne field has already been produced. The lifetime of Norne is extended through tie-ins, and the search for new tie-in candidates is an important activity to strengthen the business case for continued production beyond 2021.

Lifet ime of FPSO
The design lifetime of the Norne FPSO is 25 years; hence prolonging the production license beyond the economical cut off of 2014 was achievable without major modifications to the vessel. In order to continue production beyond 2021 a reassessment of the FPSO’s integrity is required. The Norne 2030 project has investigated several options for prolonging the life time of the FPSO.

1. Bring the FPSO to shore - upgrade and refurbish
2. Do all required upgrades offshore
3. Disconnect FPSO and produce remaining gas through sub-sea installations

The condition of the hull will dictate if the FPSO must be brought to shore (option 1). If the remaining reserves are mainly gas, then option 3 could be considered.

Volume base
Estimating reserves for a lifetime extension project involves different approaches. The work spans from developing tie-in candidates and IOR projects to estimating lifetime of existing wells. Oil volumes are particularly dependent on lifetime of existing wells.

The Future
Looking towards 2030, the aim is to reach 60% recovery on the main field. The field is already well into the tail production phase. The ambition of 60% recovery must be reached through implementation of new technology and new ideas. Currently Norne Petech is investigating the potential for subsea IOR e.g. subsea pumps, subsea separation and artificial lift. In addition, Statoil has an ambition to develop competence and new technology to produce tight reservoirs. This development will be beneficial for Norne producing the last remaining reserves.
Bygget på erfaring
Drevet av ambisjon

Edvard Grieg var vår første leketøy, vår første lurr, og blir nå vår første egensørerte oljeplattform.

Det er hittil det største utbyggingsprosjektet Lundin Norway har gjennomført. Plattformen er også det første eksempelet på at norsk leverandører arbeider kan levere det høyeste av design og kvalitet som de tette forholdene i Nordsjøen krever.

Med Edvard Grieg i drift vil vår daglige oljeproduksjon nå et nivå på 75.000 tло hver dag. Og når Johan Sverdrup kommer i produksjon i 2019 vil vår produksjon dobles.

www.lundin-norway.no
iQx™ GEO - Well Data Made Simple

by Ole-Gunnar Tveiten and Eyvind Aker, AGR

Following the success of iQx™ Experience and Offset modules for drillers in well planning and skills transfer process, AGR recently launched a new application, iQx™ GEO for petroleum engineers and geoscientists.

iQx™ for drillers

The iQx™ platform was developed by and for drilling engineers of both in-house and external reports in search for well data, equipment selection and not least, the good and bad experiences to take into consideration when planning the next well. Usually, going through previous End Well Reports requires spending the majority of time doing offset analysis, searching for data and reformattting findings in order to make data comparable. AGR has drilled more than 500 global projects, mainly on behalf of their clients and using iQx™ internally has helped them capture experiences and data from previous projects improving the company’s operating performance. The development of iQx™ began four years ago and today it is used by several companies mainly in Norway.

iQx™ GEO for geoscientists and petroleum engineers

The development of iQx™ GEO module started a year ago by sub-surface professionals at AGR. In essence, iQx™ GEO makes thousands of Petrobank files available for instant analysis without the need to browse multiple file formats. Most subsurface engineers spend time loading data from files, converting file formats to readable and interpretable data. Adding up to the need of data loading is the need to browse multiple file formats. As subsurface specialists, we can see huge benefits in terms of data capture from the Petrobank. The Petrobank is a secure storage facility, but usually requires Project Data Managers to download and streamline data for interpretation work. “iQx™ GEO ambition is to enable the end user (geoscientist and engineers) to be able to capture data directly and not relying on Project Data Manager anymore, anywhere with the only requirement being an internet connection,” AGR’s Reservoir Management team has used iQx™ GEO for a year now testing feasibility and adapting the programme to subsurface needs. After a year of testing, the software makes a significant impact on data capture efficiency. This is good news for most of us wanting to work on the analysis, not data management.

Working across disciplines

The oil and gas industry has been struggling with the data management volume, complexities and multiple copies of everything – since day one! When a well is logged, real time data is followed by rush data; then followed by end of section data; then followed by well report and finally followed by blue book reports. The well results become a “truck load” of paper, films, files, reports and experiences in people’s heads. Different sub-surface professionals use well data for a huge variety of purposes:

1. Petrophysicists use raw logs for computer-assisted interpretations of hydrocarbon content.
2. Geophysicists use logs for describing mechanical properties.
4. Petrophysicists use logs for tying wells to seismic, processing of seismic, depth conversion, fluid substitution and AVO analysis.
5. Reservoir engineers use logs for characterizing reservoir flow properties, barrier identification and to make production profile estimates. Basin analysis uses temperature, pressure, porosity versus depth, maturity measurements, HC characteristics to understand petroleum systems.

Drilling Engineers use experiences from previous wells which are crucial to success in the next.

Drilling Supervisors can efficiently find answers to actual problems during operations by browsing iQx™ GEO data or experiences. Drilling managers can supervise all drilling teams effortlessly making sure that data are being captured and compared performance between operations or development over time.

Drilling Optimization Engineer can compare several wells, drilling parameters and equipment used to continuously improve on performance.

iQx™ holds a vast amount of projects and experiences across disciplines. Across professional disciplines, drilling incidents may also be important to others than just the drilling engineer:

- Losses and shows could indicate hydrocarbon filled fractured reservoir not detected by conventional logs.
- Obviously gains and shows are important indications that a discovery could be demonstrated.
- Shalling, tight hole, bit bailing, dog-leg, hole instabil- ity, over-pull, drill break, pump pressure, lost circulation, matrix and mud additives, rate of penetration, torque, weight on bit, temperature, gas readings are all incidents relevant for different reasons and interpretations to different professionals.

iQx™ is constantly being adapted to meet requests and wishes of different professionals in terms of data capture and display function. The basic paradigm shift is that data are stored as numbers rather than files. “Imagine numbers and interpretations. Big Data made simple. Petrobank is a secure storage facility, but usually requires Project Data Managers to download and streamline data for interpretation work. “iQx™ GEO ambition is to enable the end user (geoscientist and engineers) to be able to capture data directly and not relying on Project Data Manager anymore, anywhere with the only requirement being an internet connection,” AGR’s Reservoir Management team has used iQx™ GEO for a year now testing feasibility and adapting the programme to subsurface needs. After a year of testing, the software makes a significant impact on data capture efficiency. This is good news for most of us wanting to work on the analysis, not data management.

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For many years now reservoir simulation has been a practical and accepted practice within oil and gas recovery, adopted by nearly all petroleum companies today. Running dynamic models of an asset, or a specified sector of the field, using numerical engines to predict fluid flow behaviour and quantify oil and gas recovery is seen as a best practice solution to de-risk each drilled well and ultimately optimise the overall recovery when creating a field development plan.

Over recent years we have witnessed a surge in static modelling capabilities. Huge full field models created with high resolution of associated field data that can now be constructed to create a presentation of the subsurface, allowing for better understanding of the asset. Added to this, the industry also faces very challenging wells, therefore making time-dependent predictions for field optimisation is of paramount importance. Around 30 years ago, standard reservoir simulation technologies made enterprising developments for trying to instil physics to a numerical simulation. However, many of these standard simulation packages are unable to optimise the modern supercomputer hardware platforms used today, fully advantage of parallel scalability performance, thus leading to some frustrating workarounds for reservoir engineers, constantly confronted with a difficult compromise between simulation resolution and active cell count of the model, and monetary budget for software licenses and available hardware capacity. With these bottlenecks in mind, Rock Flow Dynamics have created a reservoir simulation technology called tNavigator which allows reservoir engineers to fully explore the associated field data that is now commonly being described in the industry as a “game changer”.

Now that the reservoir engineer is in control and able to work with the model more fluently, the logistical and time constraints are removed from the simulation. Every line of tNavigator code is fully parallel giving tNavigator a scalability and performance improvements. So regardless of the size and complexity of the model it is always possible to reduce simulation time by adding more hardware. To summarise, the heritage of Rock Flow Dynamics is to ensure that high resolution simulations and huge history matching and uncertainty studies are no more than a dream but a reality, therefore the licensing policy is to include full parallel performance of all available cores within the workstation or cluster node per standard simulation engine. The high-end desktops, such as HP z840 currently have up to 36 computational cores with proper implementation of the software this hardware allows for up to 25-30 times speed-up compared to simulations on the single core. This means the simulation time for a challenging model can be reduced from 1 day to 1 hour on a workstation. For high-performance clusters, there is no limit really. The recent studies show up to 100+ and even 1000+ times speed up for large models. With the capabilities and price effective rates of modern hardware it is now possible to improve acceleration performance by almost limitless means. Meaning, if you need a faster reservoir simulation, it is now scalable on tNavigator and at a cost permitting solution.

Quotations:

“Occasionally someone comes along with a truly new approach. And is usually met with disbelief, because the status quo is always more comfortable. With over 35 years’ experience in reservoir simulation, I would like to say, that tNavigator have created this Eureka moment and have taken simulation into the 21st century. Superfast processing comes with synchronised GUI for maps, line graphs and well displays; it allows for immediate timestep by timestep analysis of the history match in progress. Stop/Break/Start technology allows for ad hoc intervention during a run, alleviating the need to wait to the last timestep; effectively conducting multiple runs in one. Interrogation of the results is so improved, that one now considers whole new data, which were previously left un-touched. Truly a game changer!”

- Bruce Stevens, Reservoir Engineering Consultant, EnQuest

“We were initially looking for a cost effective solution to our simulation needs. tNavigator provided much more than that. Its impressive multi-core capabilities, coupled with intuitive and reservoir engineering oriented features provided a step change in some of our simulation studies. Simulation runs that would take days, now can be run, analyzed and fully exploited within hours. Its user friendly design made it possible for our engineers to switch from other simulators to tNavigator in a very short time. We even actively use tNavigator for New fields. What RFD has achieved in the space of a few years is an impressive technical achievement which, coupled with a competitive price strategy, provides real and tangible value to our organisation.”

- Xavier Lopez, Senior Reservoir Engineer, VERMILION REP

“The tNavigator technology represents a game-changer for us compared to other reservoir simulation software in our organization. We not only can tackle far more complex reservoir models with the software, but we are also able to fully exploit the exceptional speed of tNavigator in combination with our assisted history matching software to significantly reduce project cycle times. This in turn has made reservoir simulation a much more valuable tool to our organization.”

- Larry Murray, Manager, Waterflood Modeling, Occidental Oil and Gas California Operations

“Having been a user of reservoir simulation for over 30 years, I was looking for the next step change in technology that allowed us to do the things we wanted to do, at the resolution we wanted, in an acceptable timeframe and at reasonable cost. RFD achieved this, and I’m sure will achieve a new level of performance in the performance/price value driver.”

- Steve Flew, Technical Director, Petrofac Malaysia

“I’ve used the tNavigator for a while now for our polymer study, but also other simulations since it’s so fast and it fits nicely into our Petrel workflow. It’s so intuitive that none of us had to attend any training course.”

- Geir–Magnus Sæternes, Reservoir Engineer, Lundin Petroleum Norway.
The Johan Sverdrup Field was discovered by Lundin Norway in 2010. Described in the media as ‘World Class Reservoir’ with ‘Champagne oil’ expectations are high. Even though the reservoir is fantastic, it doesn’t drain itself and various IOR methods had to be evaluated. One method that was studied, and still being considered, is polymer flooding. Lundin Norway carried out a polymer evaluation project with TIORCO to find a polymer suitable for Johan Sverdrup, obtain polymer characteristics for dynamic simulations and do initial evaluations. Polymer flooding cases with alternating gas injections are very calculation intensive and simulation time increased far beyond the time available in the project. This show stopper had to be eliminated in order to complete the study on time.

**NEED FOR SPEED!**

by Jens-Petter Nørgård, Lundin Norway AS

One of the large oil discoveries ever made offshore Norway, the Johan Sverdrup Field, was discovered by Lundin Norway in 2010. Described in the media as ‘World Class Reservoir’ with ‘Champagne oil’ expectations are high. Even though the reservoir is fantastic, it doesn’t drain itself and various IOR methods had to be evaluated. One method that was studied, and still being considered, is polymer flooding. Lundin Norway carried out a polymer evaluation project with TIORCO to find a polymer suitable for Johan Sverdrup, obtain polymer characteristics for dynamic simulations and do initial evaluations. Polymer flooding cases with alternating gas injections are very calculation intensive and simulation time increased far beyond the time available in the project. This show stopper had to be eliminated in order to complete the study on time.
Polymer project
Given the moderate viscosity in this field, the water-oil mobility ratio suggests that polymer flooding may have an effect. By adding polymer to the injected water it will become more viscous, hence, the water-oil mobility ratio more favourable resulting in less finger ing and a more piston like water front with lower oil saturation behind the front. Several polymers were screened based on their properties. Lab experiments were done on five selected polymers to investigate thermal stability, viscosity at different polymer concentrations, screen factors and compatibility with formation and injection water. Finally, one polymer was selected for core flood experiments with both sea water and low salinity water. A numerical model of the flooding experiments was history matched with lab results providing a set of keywords describing polymer-rock properties, adsorption and degression. This characterization is used in the full field simulation and enables calculation of polymer concentration and water viscosity of each grid cell.

Implementation of lab results in simulation model
The humpy ceiling of the reservoir implies that there may be attic oil not swept by the water or polymer flooding. Polymer Alternating Gas (PAG) was therefore considered in the study. Full field simulations with polymer flooding took long time, but alternating with gas dramatically increased the simulation time. It would be impossible to complete the study on time with full field simulations taking almost one week. An alternative plan to speed up simulations was needed. Rock Flow Dynamics (RFD) had earlier demonstrated their fast simulator, Navigator, and was contacted regarding this challenge. Polymer functionality was not supported at the time. However, RFD saw this as a natural development and entered a project with Lundin Norway to develop the required functionality. Within a couple of months a version was ready, tested and verified. Simulation time was reduced by astonishing 75-85% on a regular dual CPU workstation with 16 cores on board. The key advantage of Navigator is the simulation speed. The technology is designed to maximize the parallel performance on the modern multicore hardware. The license price does not depend on the number of cores in the workstation, so the available computational resource could be utilized efficiently. Navigator supports the conventional simulation models formats. Therefore, the project team did not lose any time on input data conversion as the existing model could be loaded as is.

With the new simulator in place, multiple sensitivities were run in order to quantify the effect of polymer. Sensitivities covering polymer injection in selected injectors vs all, selected areas vs all field, timing of polymer injection, variation in polymer concentration and polymer injection vs polymer alternating gas. Economical evaluation of the cases was done to gain some insight to what would be a good polymer strategy.

Summary and observations
The polymer experiments performed by TIORCO provided input to the simulation model. Changing the simulation platform to Navigator reduced simulation time with up to 85% on a workstation enabling simulations to be completed within the given timeframe. This initial study proved useful and more detailed IOR studies are ongoing and managed by the Working Operator. It is premature to conclude, however, some observations are worth mentioning. Polymer flooding had a positive effect in all cases. No sensitivity was done on the polymer properties; hence, results could change if e.g. polymer were to degrade faster in the reservoir than anticipated. The study showed that production increase comes several years after polymer injection starts. Rough estimates for operating cost and capital investment where available at the time of the study, so any conclusion regarding project economics is premature. However, observations suggest it may be challenging to make it economically attractive in some cases since the additional revenue from polymer flooding comes late. The study shows that the gain is not equal in all parts of the field. Incremental recovery vs polymer used suggest that polymer injection in selected areas only is more economically favourable than polymer injection in all injectors. Polymer alternating gas also indicated an upside potential, but this complex scenario needs further studying and optimization before any conclusions can be made. Prior to any investment decisions more detailed reservoir studies are required in addition to studies covering polymer type and properties, logistics, operations, handling of produced polymer and HSE aspects.
Seismic Data Attributes — new look at the old techniques

Seismic Data Attributes processing are well known techniques, but not many companies use them for exploration needs. Most on the G&G departments limit their research to AVO or to some simple “screening attributes scan” analysis. Modern software packages include attributes modules which can be applied directly to the seismic section, while more sophisticated lithology and fluid based attributes are typically handed down to other expensive software/module and required external geophysical expertise, even though they are actually of simple computation. This article is simplified explanation of several Seismic Data Attributes, which PSS-Geo AS normally compute as a part of fully quantitative data interpretation and deliver separately a product package of attributes with color codes and manual. Some of the attributes that were computed for the MCG Barents Sea Well Tie Survey are shown here.

Seismic data attributes

The traditional interpretation of seismic data is based on the tenets of the traditional seismic interpretation. Analysis of seismic data attributes gives structural and stratigraphic porosity and spatial variations of fundamental seismic data properties: reflection amplitudes, reflection phase and wavelet frequency. Quantitative parameters of seismic data can be very precious to get more information and reduce the ambiguity of the results of this modified Aki-Richards equation (Intercept/Gradient/Curvature) [1]. Geostack method described by Fatti et al. (1994) [2], and decomposition of complex seismic trace followed by Hilbert transform, see Pic. 1. Attributes and Interpretation

Several attributes were chosen to highlight Lithology and Fluid. The list and description of the attributes are presented below. Some of these attributes are shown on Pictures 3,4,5.

- Envelope (40t)/(40t+30t), q(t) - quadrature trace (Imaginary), r(t) - seismic trace, see Pic. 1. It is a magnitude of the complex trace, defined by the trace and its Hilbert transform. Also known as instantaneous amplitude. In literature, also can be called as instantaneous energy of signal or reflection strength. It shows lithology changes, bright spots, and thin-bed tuning effects.

- Fluid Factor (FFI) = (FFR)-gradient (R(t))/gradient (R(t)) = g(t)/Vs/Vp, where M is a slope of linear approximation on Fp vs Fv plot. In the examples shown in this article, to calculate g(t) Castagna sandstone mudrock line* is taken for simplification. Avseth et al (2010) [3] made a short good and concise description of all the principles for Fluid Factor computation. He summarised that brine-saturated silticlastic rocks have low reflection amplitudes, and gas rocks will be brightening up even more, because reflection amplitudes will be above the mudrock line. Carbonates, igneous rocks, and several other lithologies should be carefully studied on this attribute because they may also show brightened up. The strongest negative events in sandstone layers can be considered as hydrocarbon saturated rocks. When R(t)-g(t)/R(t)>0, it corresponds to brine saturated rocks, with R(t)-g(t)/R(t)<0, it can be considered as hydrocarbon saturated rocks. Finally, when R(t)-g(t)/R(t)>0, this is considered as a hard event. g(t) is the most important coefficient which can be calculated using available well logs data. When properly calculated g(t) coefficient along the well path, its application to the seismic section gives the most accurate lithology-based fluid indicator.

- Lithology based fluid indicator

- Instantaneous frequency

- Amplitude weighted frequencies

- Density section

- Pay zone

Examples

The examples below are some attributes displays of the 2D MCG Barents Sea Well Tie Line (Data of MultiClient Geophysical ASAS, processed by PSS-Geo AS), see Pic. 2. A long East West oriented line was chosen for


Vita Kalashnikova
QI Geophysicist
PSS-Geo AS / YP SPE Oslo / vitadep@pss-gm.com

Juri Muzi
Senior Geophysicist
OSEG Board member

Seismic Data Attributes

Help your seismic talk to you

Picture 1. Complex seismic trace

Picture 2. The MCG Barents Sea Well Tie Survey. (Data of MultiClient Geophysical ASA).

Picture 3. A MCG Barents Sea Well Tie line that crosses the Wisting discovery. Two Seismic Data Fluid Factor based Attributes. Wisting discovery is shown in black oval.
crossing the Wisting discovery. Seismic Data Attributes, described in this article, were calculated for the entire MCG Barents Sea Well Tie Survey. Several reservoirs were highlighted on the Fluid Factor related attributes which were confirmed by other attributes. The reservoirs which were not highlighted on some of the Seismic Data Attributes were postponed from the analysis, see Pic 5. This quick seismic “scan” allowed to define similarity in the rock properties, and possible pores fill.

On Picture 3, amplitude weighted frequencies of Lithology based fluid indicator attribute shows hydrocarbons in purple color. The section below is the integration of the section above. The easiest anomalies that are theoretically supposed to be related to hydrocarbons are in blue.

On Picture 4, several Seismic Data Attributes are shown for a particular area of the Wisting discovery. The top picture (a) is Rp (additional attributes, reflection coefficients), showing similarity in reflectivity across the structure. The second picture (b) is pure Fluid Factor calculated for Castagna sandstone, as described in the Attributes physics and Interpretation paragraph. Negative amplitudes indicate possible hydrocarbons in orange color. Pictures c and e are amplitude weighted frequencies of Lithology based fluid indicator attribute and its integration. The last picture (f) is the IGT section, clearly showing both top and base of the reservoir.

Picture 4. Wisting Discovery. From top to bottom: Reflection strength, Fluid Factor, Density, Two Fluid Factor related attributes and IGT section

Picture 5. The MCG Barents Sea Well Tie Survey, East line. From top to bottom: Full Stack, Fluid Factor, Fluid Factor related attribute, Pay Zone

Summary
Calculated Seismic Data Attributes are the fast scan of seismic data. Most known reservoirs that the MCG Barents Sea Well Tie Survey is crossing in the Barents Sea are nicely mapped. The attributes are developed to minimize time and risk for exploration, though they should not be used as a final prospect conclusion. It is important to know that the attributes sections are not scaled sections. The color scale should be adjusted to the working time window (except for the IGT section). Conclusion about possible hydrocarbons reservoirs can only be done when all hydrocarbon related attributes indicate hydrocarbon at the same event.

Seismic Data Attributes

Picture 5 shows a succession of another East line from the MCG Barents Sea Well Tie Survey. Several reservoirs were highlighted on the Fluid Factor related attributes which were confirmed by other attributes. The reservoirs which were not highlighted on some of the Seismic Data Attributes were postponed from the analysis, see Pic 5. This quick seismic “scan” allowed to define similarity in the rock properties, and possible pores fill.

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Stasjonsveien 18 1396 Billingstad, Norway
Phone: +47 66 98 41 10
Email: mcg@mcg.no

Solligata 2, 0254 Oslo, Norway
Phone: +47 225 60 715
Email: vita@pss-geo.com
While the Barents Sea has long been a source of frustration for E&P operators with only one field in production and one under development after 30 years of exploration, there has recently been more optimism with oil discoveries in Skrugard, Alta and Wisting. Historically, exploration wells in the Barents Sea have been drilled on the basis of seismic data and geologic structures. Since 2008, however, EMGS has begun acquiring 3D controlled-source electromagnetic (CSEM) data to provide additional geophysical information in the last three licensing rounds. Over 40,000 km² of multi-client data has been acquired to date and is being used as an interpretation tool alongside seismic.

This article will provide an update on 3D CSEM activity in the Barents Sea and through using case studies examples, will demonstrate: i) How 3D CSEM supports play models and generates valuable information on a license application phase as well as in drilling decisions; and ii) How 3D CSEM provides crucial input to prospect ranking and drill-or-drop decisions.

**CSEM – Method, Survey Design & Inversion Methodology**

Electrical resistivity of the subsurface is a physical property that strongly correlates with the fluid content and saturation of hydrocarbon reservoirs. 3D Controlled Source Electromagnetic (CSEM) data maps resistive anomalies in the subsurface, where the larger the resistive body, the greater the response. All multi-client 3D CSEM data acquired in the Barents Sea is 3D wide-azimuth data and is acquired through grids of receivers (all with multi-component electric and magnetic sensors) along with a 3 km receiver and line distance. In the case examples, the 3D CSEM data was inverted into 3D earth resistivity models.

**CSEM in the Barents Sea**

Most of the wells in the Barents Sea are concentrated in the Hammerfest Basin, the Loppa High, Hoop area and the Potheim Subplatform. Here, the geology is variable, ranging from Tertiary basins in the west, Jurassic basins (e.g., Hammerfest Basin) in the middle part, and Triassic and Permian platforms (e.g., Bjeraneland Platform and Finnmark Platform, respectively) in the east. Major uncertainties remain, however, in regard to the prospectivity of some areas. This is mainly related to the reservoir quality of Triassic reservoirs and high seal risk. New ideas and technologies are therefore needed to increase future success rates.

Between 2008 and 2013, EMGS built up a substantial 3D EM multi-client library, as shown in Figure 1 where the red rectangles illustrate acquired blocks and the case study examples are shown 1 and 2.

**Case Study 1: The Hoop Area**

One key discovery in the Hoop is the Wisting prospect in Lower Jurassic reservoir rocks. In September 2013, the Austrian oil company OMV announced an oil discovery in license PL537 on the Wisting prospect with an oil column of 50–60 m and potentially recoverable reserves of 60–130 MMboe. The following year a new oil discovery – Hanssen – was announced in the same license. In the neighboring license there was a gas discovery, Mercury, the same year.

All discoveries are associated with a significant EM anomaly as can be seen in Figure 2. The illustration shows a 3D CSEM inversion overlaying high resolution seismic for the Hanssen, Wisting and Mercury wells – all of which built up a substantial 3D EM multi-client library, as shown in Figure 1 where the red rectangles illustrate acquired blocks and the case study examples are shown 1 and 2.

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**Figure 1. An overview of EM acquisition in the Barents Sea. The case study examples are shown 1-2; red rectangles indicate blocks where CSEM was acquired**

**Figure 2. The Wisting, Hanssen and Mercury Discoveries where the white lines indicate wells and where the very high resistive anomalies represent hydrocarbons and show an excellent conformity to structure**

**Figure 3. A structure map and CSEM Results two blocks Northwest of the Wisting Discovery. The depth structure map (left) indicates a large, shallow structural closure (contour interval 50 m), whereas the CSEM anisotropy anomaly map (right) shows resistive anomalies in the northern part**
were successful. The high resistivity (highlighted in red) indicates hydrocarbon charged reservoirs. However, there are also examples where seismic amplitude anomalies are not associated with high resistivity, severely limiting the possible outcome of such a target.

Different Play Models Requiring Further Investigation

These discoveries also open up additional oil discoveries in the area with CSEM data revealing large anomalies for further investigation. Some have argued recently, for example, the case for an increased focus on a different depositional environment in the upper Triassic (Kjølhamar, 2012). This idea is supported by the inversion results from the CSEM data, where CSEM anomalies are present in the area where these Triassic reservoirs are assumed to be present (Famouøs et al., 2013). This also raises fundamental questions as to which play models should be pursued: the resistive Triassic target or the Jurassic target even though there might be a mismatch between seismic and CSEM?

When studying the map for two of the blocks in the area (see Figure 3), it can be seen that there is little correlation between the shallow Jurassic structure and CSEM anomalies. This suggests that if the anomalies are caused by hydrocarbons, the traps will purely need stratigraphic closure and/or fault seal. In addition, these resistive anomalies seem to represent a deeper source for resistivity than the Wisting Discovery. Making the right decisions between Triassic and Jurassic targets will be of enormous value to the industry, especially as the same question applies for many of the other Hoop area licenses. An integrated approach that includes CSEM, seismic AVO and inversion, well results, and other geologic information will be crucial in achieving this.

Case Study 2: The Polheim Subplatform and Bjørnøyrenna Fault Complex - Looking for Analogs

The Polheim subplatform and the Bjørnøyrenna fault complex separate the Loppa High to the east from the Bjørnøya Basin to the west. Skrugard and Havis were discovered on the Polheim subplatform in 2011 and 2012. Figure 4 shows seven wells in the area where CSEM provided a correct prediction for the Lower Jurassic and Lower Cretaceous plays along the Bjørnøyrenna Fault Complex. Three of the wells are significant discoveries (Havis 7220/7-1, Skrugard 7220/8-1, and 7220/3-1). Skarl (7220/7-2) also revealed oil and gas predicted by CSEM, although it was a small discovery. Together these discoveries demonstrate the Johan Castberg field development.

Three wells are non-commercial or dry (7219/9-1, Salina 7220/10-1, and Nunatak 7220/5-2), demonstrating CSEM’s ability to distinguish between commercial and non-commercial hydrocarbon bearing reservoirs. Recently, two more wells have been drilled on the Polheim Subplatform: the Kraaneveld (7220/4-1) and Drivis (7220/5-3). Both wells report small amounts of hydrocarbons below the sensitivity range of the CSEM technology.

Figure 5 shows three leads on the Polheim subplatform alongside the Bjørnøyrenna Fault Complex where multi-client 3D CSEM and 2D seismic data are integrated.

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ly is uncertain. The two first leads in Figure 5 also show resistive anomalies in Lower Jurassic sand located in a rotated fault block. One of them shows also indications of a flat spot on the 2D seismic data. These leads are interesting because they can be regarded as analogs to the Havis and Skrugard discoveries.

The result of combining CSEM with marine seismic is the identification of a number of new leads and vital information for prospect ranking and drill-or-drop decisions.

Conclusion

While exploration history in the Barents Sea cannot be considered successful to date, the emergence of CSEM data as a complementary tool to seismic raises reasons for optimism, especially as there are large unexplored areas (in the range of 100,000 km²).

With the coverage of 3D multi-client CSEM data allowing for the calibration of more than 20 wells - some drilled before and some after CSEM acquisition - for all these wells CSEM accurately predicted the outcome of drilling. This knowledge can in turn be used to better de-risk new prospects. Based on this convincing track record to date in the Barents Sea, CSEM data when interpreted alongside other geophysical and geologic information can have a crucial influence on exploration decisions - where to and where not to drill, license applications, prospect ranking, drill-or-drop decisions, and farm-in/farm-out decisions.

Acknowledgments

The authors would like to thank the Society of Exploration Geophysicist and Interpretation for permission to re-publish some of the material in this article (found in Interpretation, ‘CSEM as A Tool for Better Exploration Deci- sions’, August 2014) and the European Association of Geoscientists and Engineers for republishing material found in First Break Magazine (‘The Impact of CSEM on Exploration Decisions & Seismic’, November 2014). Some examples are also taken from the joint project between EMGS and MultiClient Geological ASA for seismic and CSEM integration and cooperation between EMGS and TGS.

Figure 4. Seven wells where CSEM provided a correct prediction for the Lower Jurassic and Lower Cretaceous plays along the Bjørnøyrenna Fault Complex.

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Paper 31: The First Break


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Today the vast majority of drilling companies use mud-pulse telemetry for transmitting measurements and logging while drilling (MWD/LWD) data to the surface in real time. However, external conditions like pumps, mud consistency, and drill string movements reduce the quality of data received at the surface. Obstacles that decrease the percentage of decoding include sporadic noises caused by drill string movements and mud motor operation, as well as ongoing noises created by pumps and electric systems on the rig. In addition, the signal level from MWD systems decreases as depth increases, making the transmission channel less reliable as drilling progresses.

Transmark EDS, one of the most experienced directional drilling companies in the North Sea region, operates in extremely challenging conditions. They often are forced to place mud pulse MWD systems below the motor or use them in conjunction with rotary steerable systems. Such workarounds create significant decoding challenges. Based on the recommendations of other drilling contractors, Transmark EDS decided to try the recently developed Axel Surface Unit to reduce the effects of pump noises and high torques on their operations as shown in Figure 1. Axel is an independent MWD manufacturer founded in 2012 in response to a market need for standardized communications for MWD/LWD systems operating in extreme environments. Axel’s first major goal was to improve decoding quality in mud pulse telemetry by developing a universal surface solution. Their solution, the Axel Surface Unit, offers hardware and software compatible with different types of MWD downhole tools. Axel’s team successfully implemented advanced signal processing algorithms and cutting-edge machine learning techniques to take decoding systems to the next level. When Transmark EDS started drilling with Axel in 2014, the unit was quickly developing a reputation as the best surface system available on the international market.

Initially, Transmark EDS ran the Axel Surface Unit in parallel with their previous surface solutions. Comparative performance testing showed that Axel outperformed competitors during drilling in the North Sea region. The Axel Surface Unit consistently decoded sections for which other systems showed poor decoding or no decoding at all.

Axel’s superior performance is based on a combination of features for noise reduction, including specially designed smoothing and correlation filters as shown in Figure 2. A manual toolkit allows MWD engineers freedom to manage the decoding process in real time and manually decode the most problematic signal intervals. This significantly improves decoding quality and resolves many decoding issues.

Axel’s technical team is very responsive to client requests. The flexible and scalable architecture of each unit makes it possible to quickly build case-specific improvements and push software updates to operating surface units while drilling is in progress. Based on data provided by Transmark EDS, Axel was able to start work on a universal filter solution for noises caused by rotary steerable systems. The Axel technical team will be glad to present the results when the work is complete.
Smarter and greener

The oil business is currently challenged by a low oil price, increasing cost and a demand for more sustainable operations. If the industry is to become more efficient and if renewables are to be proved in a commercial setting, it is a need for collaboration.

While wind intermittency may be a challenge for many oil and gas applications, the water injection process can handle some degree of intermittency as long as a specific volume of water is injected over a given time period. This power supply can be combined with relevant water injection technologies to provide water of required quality to the reservoir.

The upstream industry has for many decades injected water into oil reservoirs to increase recovery. Traditional solutions using pumped injection water are impacted by the necessity for long power cables and water injection flowlines, which are significant cost drivers. The systems are energy-intensive and space consuming.

Floating wind turbines have in recent years emerged as a promising technology for large scale renewable power production. Several full-scale offshore pilot turbines have delivered promising results which build on the knowledge from both the offshore oil and gas industry and the wind power industry.

Initial DNV GL studies suggest there are opportunities for a new generation of wind-powered water injection systems used to increase reservoir pressure. There are several advantages, such as extending the life of marginal and mature fields, and reduction of both costs and emissions from offshore oil and gas installations.

The system could be installed without costly retro-fittings on the platform, it could provide access to systems normally located sub-sea and increase the flexibility of the injection location and reduce the installation time. It could also be possible to move the system to applications with and use it at new locations after the closure of a well or field.

The Concept

The WIN WIN concept is based on a floating wind turbine system that is separated and at a distance from the production platform. The power for the water treatment systems, injection pumps, and the auxiliary systems will be supplied by the wind turbine generator itself. The economic rationale is dependent on the characteristics of the field. The best business cases for fuel is limited and tie-back to other production hosts or import of fuel are the main alternatives.

Technical considerations

High level studies indicate that the stand-alone wind powered system is technically feasible and potentially cost-competitive to alternative solutions. To deepen the knowledge and develop a more detailed understanding of the system with its opportunities and challenges, the JIP will take a detailed approach through analysis of a number of technical and economic case studies reflecting the operators needs and real-life experience.

Building on the results obtained from an earlier study by DNV GL, some of the critical issues to be addressed by the JIP are:

- Reservoir characteristics and well system
- Floating wind turbine system design and selection of wind turbine
- Operational challenges and pump intermittency
- System stability and availability
- Power outages and black start capability
- Economic and regulatory aspects

Conclusion

The aim of the JIP is provide enough information to give the industry confidence to develop the WIN WIN concept into an actual project. Participants in the project now include a handful of operators from several countries. A successful integration of offshore wind power with offshore oil and gas operations could provide the oil and gas industry with new and cost-efficient means to develop marginal reservoirs and increase production in mature fields with long step-out distances.

DNV GL has just kicked off a Joint Industry Project (JIP) called ‘WIN – WIN – Wind powered Water Injection’ to assess the technical and economic feasibility of using floating offshore wind turbines for powering subsea water injection systems for increased oil recovery (IOR).
The downward trend in oil prices has marked the longest decline since the US travel and leisure industry organization, the AAA, started tracking retail gasoline prices 15 years ago. But for oil and gas companies, that recent stabilisation is hardly any comfort. The current price still represents a nearly six-year low and, considering the geopolitical landscape driving the price of oil – ever-downward at the moment – it’s clear that gasoline prices simply aren’t going to bump back up substantially any time in the foreseeable future. So, what does big data and analytics must do with the price of gasoline? For the oil and gas industry, a whole lot. Simply put, to weather this storm of deflated a true picture of what is most cost effective in terms of avoiding non-productive time, scheduling maintenance against overall productivity based on recorded equipment usage, and when to buy, sell, develop or defer. This is always the case, but the stakes are even higher now, considering the state of the industry and price of oil. This “true picture” requires more than integrating data spread out across various business units – it requires accessing and integrating data that’s across an ecosystem of contractors, partners and stakeholders. In this example, decision-makers in the oil and gas industry must know full lifecycle costs of their organization and across their operations. Without the right technology and, considered the geo-economic and poli
tical landscape driving the price of oil, the disruptive explosion of massive amounts of time series data can be placed in Hadoop ecosystem has all of the components to ingest and process data describing complex relationships. With regard to tech-
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house, but that’s not the same as a true picture of what bringing together outside data and making sure it can actually be analyzed.

Data warehousing has long been the scale-out solution for integrating large amounts of data to quantify well-defined relationships for immediate business use. However, the disruptive explosion of massive amounts of time series data from sensors and loggers means that a rethinking of processes and practices is required. The secret is in shared, (Big) Data – Driven Insights. What is the “Connected Well?” At its core, it’s built on the same foundation. Self-quantified. Self-identified. Self-realized. The Connected Car paradigm is a conceptual framework by which an industry can understand the value of bringing stakeholders together around a particular ecosystem of physical and virtual elements. The forward-looking manufacturing, aerospace and automotive industries have employed such a framework to bounce back from industry upheaval. Just like oil and gas producers, these industry invested heavily in sensor technology over the last decade. But, the idea of using this kind of data to make better business decisions isn’t (or at least shouldn’t be) new. The key is, when things got tough, these industries took the important next step of integrating and analyzing that high-volume data (like data from sensors) in conjunction with financial, logistics, equipment condition and usage data across their organization and across their industries. Consider what could happen in the oil and gas industry if we brought this concept to operations, reservoir, production and maintenance domains, integrating them under a “Connected Well” approach. For example, decision-makers in the oil and gas industry must know full lifecycle costs of any given well, from exploration to abandonment, in order to have effective in terms of avoiding non-productive time, scheduling maintenance against overall productivity based on recorded equipment usage, and when to buy, sell, develop or defer. This is always the case, but the stakes are even higher now, considering the state of the industry and price of oil. This “true picture” requires more than integrating data spread out across various business units – it requires accessing and integrating data that’s across an ecosystem of contractors, partners and stakeholders. In this example, decision-makers in the oil and gas industry must know full lifecycle costs of their organization and across their operations. Without the right technology and, considered the geo-economic and political landscape driving the price of oil, the disruptive explosion of massive amounts of time series data can be placed in Hadoop ecosystem has all of the components to ingest and process data describing complex relationships. With regard to technology, companies need a platform that can grow with the increasing data demands, and enable analytics that is fast, easy, accurate and ready to put into production. Lots of oil companies have already worked to integrate their own data into one data warehouse, but that’s not the same as a true picture of what bringing together outside data and making sure it can actually be analyzed.

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other. You need to actually put people in the same room and bring disparate teams together—until you can do that efficiently you aren’t doing it right. So why isn’t this happening in Oil and Gas? The gaps in understanding between what technology companies have to offer and what the oil industry requires for this digital transition need closing. It doesn’t suffice for tech companies to namecheck Big Data and Cloud and hope that it will do the trick—there are a lot of gotchas in this industry: from the high science; to the fact that the data often outlives the applications and even the people who work on an oilfield.

Domain expertise is a fundamental prerequisite but there also needs to be an investment in a data-driven and analytical mindset on the part of the oil companies and the service companies to understand how this new connected world will function. Any organization that can bridge this gap will be highly valued—from the analytically-minded scientific consultancies, to analytics and data science teams working as centers of excellence in the service companies and operating companies. The transition will be more about people and processes than technology, and it will require much closer cooperation between the operating companies, the service companies and the technology companies to make it work.

The bottom line is that there is a storm raging in the oil and gas industry—thanks to myriad factors—that’s not going to go away for foreseeable future. On a philosophical level, that means companies need to really focus on what they can control in order to survive. On a practical level, a large part of that means putting the right technology and communication processes in place to make more out of the big data that’s out there, beyond the four walls of the business units, and ultimately beyond the business.

Just like the manufacturing, aerospace and automotive industries, oil and gas will learn and evolve in the face of adversity. And, ultimately, I have no doubt that it will become a model for other sectors to follow. In a data-rich world, this quantified and connected evolution is an inevitable one that will spread like wildfire across industries.

Dr. Duncan Irving presented “Big Value from Big Data” at the Conference “Big Data Solutions & Analytics in Upstream Oil and Gas Industry” in Oslo, on February 10th. All the presentation from the Conference are posted on the web site at http://oslo.spe.org/bigdata
The volatility of today’s global economy has led to an increased awareness and focus on the surplus cost of underutilized IT assets. By metering the usage of software applications and other IT assets, companies stand to gain a lot in cost optimization, asset efficiency and user efficiency.

Software metering tools: An Undervalued Source of Increased Efficiency and Savings
by Signe Marie Stenseth, SMS VP Open IT

Software metering tools are essential to running our companies, connecting with our customers, generating new business, differentiating us from our competitors, and even inventing our products. Almost every major company relies on general business applications, specialized or scientific applications, and extensive systems tools that operate in the background to make the company perform. We all are aware that software is not an optional asset, yet surprisingly few companies manage their software with an enterprise perspective or a long-term view of the investment.

Software is often unmanaged in the sense that there is little knowledge about who is using what applications when, for what purposes, or how efficient—all including the frequency of use compares to the number of software licenses purchased. The relevant IT management questions remain: Are we utilizing our most expensive IT assets efficiently? Have we aligned our licensing of software assets with the goals of our organization? Such lack of management can be due to a variety of reasons, including technical or organizational complexity and a dismal track record of consulting projects trying to address IT Asset Management. Whatever the reasons, the volatility of today’s global economy has led to an increased awareness and focus on the surplus cost of unmanaged IT assets, as well as improved technical solutions to manage such assets. Companies wanting more responsive IT management, reductions in the total cost of ownership, and improved user efficiency can implement technical solutions to achieve this. This article will identify the benefits of software usage metering and optimization, based on first-hand experience from working with companies implementing processes and systems for cost optimization and asset efficiency.

1. After a decade-and-a-half of work with Global 1000 organizations, we have found:

   a. The more expensive the software applications are, and the greater the dependency on these applications for profit growth, the more likely companies are to value solutions that can help them with cost optimization, asset efficiency and user efficiency.

2. By tracking software purchased against what is actually used, and applying this information in contract negotiations with key vendors, companies are able to cut the cost of software ownership by at least 25%.

3. An overview showing how extensively certain applications are used throughout the organization is valuable information for the application support team for directing efforts of user training and support. When applications or features are not fully used, and software is in use and what they cost.

4. Collaboration between an independent software vendor and the software vendors delivering business and systems applications can also be highly instrumental in delivering value to companies that buy software. For example, Open IT is a partner with both Schlumberger and Halliburton (Landmark), two software vendors for the oil and gas E&P market. As customers are increasingly demanding flexible license agreements, these partners saw the value in a partner offering tracking of usage of their tools, and chose Open IT to deliver this capability. End-users can now follow the full life cycle of applications from the uptake of new technology to the retirement of old versions and features. Insights into the usage of applications and features, while helpful to managers at end-user sites, can also aid the software provider in getting precise customer feedback on products and features valued most, so that we then focus this feedback back to R&D.

5. A successful Asset Software Management program includes repository, inventory and usage metering. All this can take time to implement, but savings can begin immediately when companies implement a software usage metering and optimization component to their software portfolio.

6. Our experience shows that a company can expect a return on investment within six months of implementing a usage metering system, depending on when contracts are up for negotiations.

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E&P competitiveness advantages from Cognitive decision support

by Ole Evensen, WW Chemicals & Petroleum, Upstream Leader, IBM

The E&P industry has always been “data driven”, willing to invest in new technology to improve data acquisition, interpretation, simulations and analysis. While still necessary, the historical approach to insight and decision-making is no longer sufficient. New technology may change the playing field.

Exploration success sometimes seems arbitrary, even lucky. Major discoveries in previously explored areas haven’t been as strategic as “why did we not previous licence holders succeed?” The simple answer may be – the data available, and the insight made possible – at the time of decision making. We make different decisions today, to drill, drop or decide a new location – we have the advantage of additional insight from new data – as well as the results from previous efforts. We have the potential to think outside the box - of previous assumptions and outcomes. This potential will depend on the organizations ability to explore new and exploit internal or external sources of information. This capability may be different between successful and failure, success and how we will perceive industry leadership.

Improving the basics is not enough

Most companies adopt the “basics”; like improved seismic acquisition, more sophisticated geocell applications and cross-functional collaborative work flows. They try to cope with the increasing amounts of “big” data, from wells, drilling, events and present the best next actions to avoid them, or minimize their impact. Improved drilling efficiency by avoiding stuck pipe is an example of benefits from this approach. While this is a high impact improvement, it still is not enough. Improved drilling efficiency is a must point if the well should not have been drilled in the first place, or in a different place.

The illustrated below (high level) Well Delivery process may highlight the different types of insights and decision making required when planning and executing a well delivery.

While there is a lot of effort invested in the execution part, where real-time analytics drives actions today, there is a lack of decision support in the preceding phases, where major and critical decisions are made. Concept selection, locations, tractions, rig selection etc. depends on our ability to understand natural language, with a human style of communication. This includes understanding of industry “lingo” – the semantics and ontology. Searching for “wildcats in the North Sea” will narrow search to exploration drilling, and return – among other results - data from Johan Sverdrup, as the system would know that this field is part of the North Sea area, even if it was not stored or stated in one of the sources.

2. Generate and evaluate evidence-based hypothesis. A cognitive system employs an “assessor”, which cannot process data in a structured way, and returns hypotheses to the user. The hypotheses are comprehensive, the payback is immediate – whether you are looking for “exploration boldness” to make a step change in reserves growth opportunities or the perception of risk being left behind. Similarly, production companies often have confidentiality issues to get a competitive edge in situations where an “advantage of insight” may influence drill-drop, buy-sell – or the perception of “right price”. Most of these ongoing projects are confidential, however we may not have a business impact within E&P is enormous. While these projects are comprehensive, the payback is immediate – when the business value of improved appraisal, better understanding of what to expect during drilling – or even a “drop” – decision that saves the cost of a dry well. While exploration is a hot area, valuable volumes of data are also adopting cognitive technology to obtain new and better insight. Operations and analytical competencies are considered the most relevant or analogous, previously developed – with lessons learned.

3. Adapt with a timely feedback, building on timeliness and outcome feedback. Building on the characteristics, generated by a comprehensive, the payback is immediate – whether you are looking for “exploration boldness” to make a step change in reserves growth opportunities or the perception of risk being left behind. Similarly, production companies often have confidentiality issues to get a competitive edge in situations where an “advantage of insight” may influence drill-drop, buy-sell – or the perception of “right price”. Most of these ongoing projects are confidential, however we may not have a business impact within E&P is enormous. While these projects are comprehensive, the payback is immediate – when the business value of improved appraisal, better understanding of what to expect during drilling – or even a “drop” – decision that saves the cost of a dry well. While exploration is a hot area, valuable volumes of data are also adopting cognitive technology to obtain new and better insight. Operations and analytical competencies are considered the most relevant or analogous, previously developed – with lessons learned.

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The 10 Million Tag System aka the Enterprise Control Foundation
by Timo Klingenmeier, General Manager / Software Architect, inmation

The First
by Timo Klingenmeier, General Manager / Software Architect, inmation

Today, we talk about scale for large enterprise systems. The term "Tag" refers to a named item or object in this domain – usually associated with an industry nature not so well handled as it could be in a central Data Center, managed by the central IT group of the corporation. This situation led to a certain gap between the local engineers and central IT, which is also centrally managed and primary processes, even comprising all operational assets of the entire enterprise? Including the corporate workforce. Plus a security mechanism that takes this huge address space of information to the corporate workforce. For example, a flexible layer which routes information to critical processes given a secured connection. But what does it take to create an Enterprise Control system, no local system. The developers at inmation have been in industrial system integration business for more than two decades. We have learned from building global real-time data infrastructure projects on behalf of industry leaders. Fuelled by this spirit, system:inmation, our own new product is designed to enable Enterprise Control in a much simpler way than this was ever possible before.

remote control sequences. Obviously, it is not intended to start an exotic chemical reaction from thousands of miles away by a junior fellow playing with the system in the headquarter cantina. Sure, the StruNet demon appears on stage, once someone starts to mention remote control. But, it must be possible to initiate certain processes automatically from remote. Without downlink writing, there is no Enterprise Control. The answer is uncompromised security whenever a wire leaves the controlled space on its way to the remote controller. This includes a lot of checklists, but it must be standardised and maintained. Not to forget No-Spy agreements with all involved parties and periodic penetration team missions on hire. And inside the system (including all interfaces it supplies for the integration on Enterprise IT level), per-object security control must be implemented. Each access requesting the system can either: clear the server must be authenticated to the Enterprise AD. No compromise there! The system must be built not making any assumptions that remote links are always available. It must provide easy-to-maintain, self-monitored and multi-strategy redundancy. It must buffer collected data which can not be routed upwards. It must reject control commands which can not be forwarded downwards. All events of our Enterprise Control system must be collected centrally and also serve as a single source for any emergency notifications. No, dear vendor, a text file on the hardisk is not considered a log. In a similar fashion every other data has to be stored centrally. Time-series, alarms, events, aggregates, forecasted values, structural data, metadata... It must all be stored. Using the same database system. Guess, this is not SQL-Based. We want to cluster to the infinite, quickly and easy to maintain. Horizontally scaled, using multiple instances of moderately muscled machines. We want to add to it and failover system evolves. How can it do so, if only highly specialized staff can ever tame the beast? It is true, the internal corporate IT and their partners must be the owner and skilled personnel from operations, engineering, finance and administration must be the stakeholders. And yes, a good, super-regional system-integrator may still be a good option. But finally, the system must – as central and large it internally is – also allow for par- tial administration by division, site, branch or department. Defining an object level again, it must be able to control security to the finest grain, but open and extensi- ble for others. The developers at inmation have been in industrial system integra- tion business for more than two decades. We have learned from building global real-time data infrastructure projects on behalf of industry leaders. Fuelled by this spirit, system:inmation, our own new product is designed to enable Enterprise Control in a much simpler way than this was ever possible before.
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<th>Date</th>
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<tr>
<td>May 18, 2015</td>
<td>Harstad</td>
<td><strong>Distinguished Lecturer Klaus Potsch, Formerly OMV E&amp;P</strong>&lt;br&gt;Understanding and Checking the Validity of PVT-reports.</td>
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<td>May 19, 2015</td>
<td>Oslo</td>
<td>SPE YP Lysefjord Cruise&lt;br&gt;SPE Young Professional invites you to the summer event of 2015, our traditional Lysefjord Cruise Trip!</td>
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<td>May 26, 2015</td>
<td>Stavanger</td>
<td><strong>Risks and Rewards in Oil and Gas: Navigating in a Volatile Oil Price Market</strong>&lt;br&gt;Society of Petroleum Engineers (SPE) Oslo Section in partnership with Oslo Børs and PwC for the third consecutive year has gathered some of the key people in the industry to discuss the status of the oil industry in the volatile oil price market on May 27th, 2015. Building on the successes of the previous years’ seminars, this time we focus on the volatility of the oil and gas industry and the implications to the E&amp;P companies. NPD will share with us their view on the NCS. With the current re-pricing of the oil sector, cash is king and cash-strapped companies might be subject to take-overs. Oslo Børs will present the rules of the game for this activity. Detnor will share their views on the take-over of Marathon. ABG Sundal Collier will share their view on the future of the oil sector and the implications to the E&amp;P companies. Detnor will share their view on the future of the oil sector and the implications to the E&amp;P companies. PwC will present their view on the future of the oil sector and the implications to the E&amp;P companies.</td>
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<td>May 28, 2015</td>
<td>Harstad</td>
<td><strong>Young Energy Breakfast at Det norske</strong>&lt;br&gt;SPE Bergen Sailing&lt;br&gt;Every May, we host the SPE Bergen Sailing with Statsraad Lehmkuhl. The annual sailing is always a sell-out, and 350 participants including students enjoy a full evening at sea with excellent food, drinks and networking.</td>
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<td>May 28, 2015</td>
<td>Bergen</td>
<td><strong>SPE BBQ</strong>&lt;br&gt;ICoTA Well Intervention Seminar&lt;br&gt;Keynote speaker: Jarle Haga, Manager, Drilling and Wells, Talisman Energy Norge AS.&lt;br&gt;An one-day seminar of technical presentations sharing experience, innovations and case studies focused on well intervention. An exhibition of the latest services and technologies in the intervention market and opportunities for networking complete this valuable day.</td>
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<td>June 5, 2015</td>
<td>Stavanger</td>
<td><strong>SPE Bergen Lutefisk</strong>&lt;br&gt;Another steady tradition is our annual Lutefisk dinner in November. Some 150 participants enjoy the Lutefisk with its proper add-ons. This is Norwegian pre-Christmas culture at its best, and always a great success.</td>
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<td>26. November 2015</td>
<td>Bergen</td>
<td><strong>SPE Bergen One Day Seminar</strong>&lt;br&gt;The annual SPE Bergen One Day Seminar is our largest event during the year. The international combined technical conference and exhibition is held in Bergen, every spring and is visited by roughly 500 delegates. The conference offers multiple full-day parallel sessions of technical presentations. The exhibition covers some 2000 m2, and some 40 companies are represented with exhibition stands.</td>
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<td>20. April 2016</td>
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Thank you!