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SPE NEWS

COPENHAGEN SECTION

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# KEEP CALM AND AVOID DISASTER

Health, Safety and Environment (HSE) have recently been higher on our radar than usual thanks to an October SPE Distinguished Lecturer presentation on incident prevention, and by the recent Deepwater Horizon movie.

In his October lecture, Ron McLeod, a Heriot-Watt University professor, described the 2005 explosion at the Buncefield (UK) fuel storage site. While the official investigation focused on technical malfunctions, Ron's engaging lecture discussed the role of human factors. He elaborated how too much reliance on human performance as a barrier contributed to the explosion. One point he made was that competent people were tolerating technical malfunctions that in isolation were considered non critical, but in combination led to disaster. Ron emphasised the need to critically analyse prevention and mitigation measures in the bowtie approach and illustrated how hidden interdependencies can fatally weaken human defences.

The Deepwater Horizon movie reminded us, in dramatised Hollywood style, of the inherent risks of drilling into highly pressured oil and gas accumulations. From an accident investigation perspective, however, the movie is not very helpful. It places blame for incidents that led to the 2010 Gulf of Mexico Macondo well blowout and oil-spill largely on specific people, like BP's company man Don Vidrine, rather than on a wider systemic failure.

The bowtie approach reveals that the real cause of most disasters is not so much the visible accident "but the failure to identify the accident early in its birth". The Macondo well blowout demonstrated that a series of small mistakes and misjudgements, not considered critical in isolation, can spiral into disaster. The incident also made clear that at a higher level the entire oil industry and regulators had been overconfident when it comes to deepwater drilling and had not put in place effective measures to prevent and mitigate disaster. Over the decades the risk tolerance for ever deeper wells had crept up.

Procedures don't necessarily make up for human error and overconfidence in protection mechanisms. It is assumed that people will always do the right things when mechanical systems fail, which is far from certain.

The prevalent approach to improving safety is to raise awareness of our vulnerabilities and constantly reinforce vigilance so that we can take steps to minimise the likelihood of incidents. Perhaps this is not enough by itself and efforts should be made to involve more independent eyes in the operational decision making processes. One cannot replace frontline supervision but the quality of decision making in the HSE arena might well benefit from an organisational approach that involves more people with a holistic understanding of the activities, either on-site or via real-time monitoring. We should ensure that choices about organisational structures are not contributing to incidents.

Hans Horikx
Copenhagen SPE Chairman

SPE

COPENHAGEN SECTION

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# SMART "COO INJECTION B

Whenever water is injected into a reservoir in order to produce more oil, it is necessarily salty. Smart addition or removal of the salts from the injected brine has shown a potential to increase the recovery. This is a relatively low-cost and low-risk improved recovery method – provided that it works. Finding the right composition of the salts in the injected brine may be a tricky problem, especially in the context of high reservoir temperature and complex interactions of the different salts with the reservoir minerals. The "brine-cooking" problem may be especially difficult, since the mechanisms, by which the salinity works in carbonate reservoir rocks, are not fully understood. There is currently not consensus among different scientific groups about these mechanisms. Experimental data may also be controversial: Apparently, chalk samples from different locations can respond differently to the injected brines. The role of the reservoir temperature is also far from well understood.

The problem of smart water flooding of the petroleum reservoirs of the North Sea was attacked at the Center for Energy Resources Engineering (CERE) at DTU within the framework of a four-year SmartWater project, where chalk and greensand samples were flooded. Three PhD theses were defended recently this year, each studying smart water flooding from different points of view. While the recent findings about the importance of some specific ions for additional oil production from chalk were basically confirmed, the chemical and physical mechanisms, resulting in additional recovery, were found to differ from what was reported previously in the literature. In particular, it was found that in-situ scaling, precipitation of solids and formation of reservoir fines may facilitate recovery. This novel mechanism was discovered by analysis of a large set of the available experimental data, as well as inferred from own advanced flooding experiments. Kinetics of the brine-rock interactions was also found to be of importance: while some reactions take place in no time, others require months and years to proceed. Additional important information about the behavior of the oil-rock-brine surfaces was obtained by the application of nuclear magnetic resonance (NMR). The findings of the project may result in a more reliable and productive application of smart water under conditions of the Danish petroleum reservoirs.


The SmartWater project was supported by the EUDP – Energy Technology Development and Demonstration Program, as well as by industrial participants Maersk Oil and DONG E&P. Grant holder and PI was Professor Erling H. Stenby, and the project was coordinated by Professor Ida L. Fabricius. Three PhD students: Krishna Hara Chakravarty, Konstantina Katika, and Artem Alexeev, received researcher training and conducted the research in the project under the supervision of CERE faculty members including Associate Professors Kaj Thomsen, Philip Loldrup Fosbøl and Alexander A. Shapiro.


# KING" OF THE
# RINE AT CERE, DTU

# ABSTRACT

## Particles in Pores: Enemies and Friends

Fine particles naturally appear in the rocks of the petroleum reservoirs. They may be released when the brine of a modified salinity is injected in order to produce oil. The fines or bacteria are also contained in the injected brine, causing the the injectivity decline and possible formation damage. How deeply can particles penetrate? How are they released? How do they plug the pores? The recent research gives a new insight on these questions. ▶

# BIOGRAPHY

**Alexander A. Shapiro, Associate Professor at CERE**

Alexander A. Shapiro is Associate Professor at CERE – Center for Energy Resources Engineering, Department of Chemical and Biochemical Engineering, DTU. He is Head of studies for the Master program in petroleum engineering at the DTU. The research interests of A. Shapiro are related to fluids and particles in porous media, with application to the problems of petroleum and chemical engineering, where he has published several ten per-reviewed papers and supervised 20 Ph.D. students. ▶

# ABSTRACT

## Mineral Precipitation from Brines

Pressure changes, temperature changes, and mixing of incompatible brines can cause mineral precipitation in oil fields and production equipment. If brine compositions, temperature, and pressures are known, the potential for mineral precipitation (scale formation) can be calculated. Mineral precipitation should not always be considered a problem, but might sometimes contribute to increasing the recovery factor. ▶

# BIOGRAPHY

**Kaj Thomsen, Associate Professor at CERE**

Kaj Thomsen is Associate Professor at CERE – Center for Energy Resources Engineering, Department of Chemical and Biochemical Engineering, DTU. He holds M.Sc. and Ph.D. degrees in chemical engineering from DTU. Kaj Thomsen is an expert in thermodynamics of electrolytes, including the problems of corrosion, freezing/melting of the water solutions, as well as mineral and salt precipitation. He has published many research papers on the subject and has been a main supervisor for 10 Ph.D. students. ▶

# ABSTRACT

## What Makes Chalk Stick Together

Chalk will typically leave your fingers white, if you touch it, so is it just a more or less densily packed sediment, or is it a cemented sedimentary rock? What is the role of friction and cohesion? The answer is relevant for example to the discussion of how pore-fluids influence the stiffness and strength of the chalk. ▶

# BIOGRAPHY

**Ida L. Fabricius , Associate Professor at CERE**

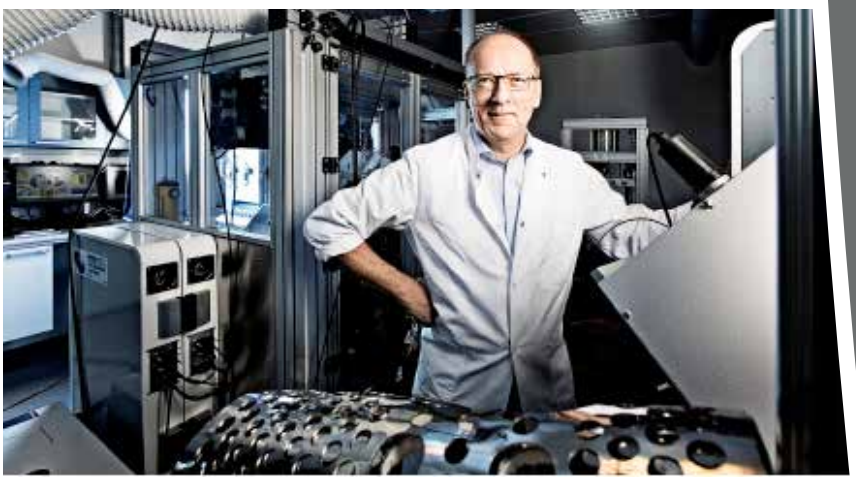
Ida L. Fabricius is Professor at CERE – Center for Energy Resources Engineering, DTU Civil Engineering, where she is coordinator of the Geophysics Research Group. She holds a B.Sc. in chemistry, M.Sc. in geology, as well as Ph.D. and Dr. of Science degrees in technical geology. She joined DTU in 1985, after a few years as development geologist at Mærsk Oil and Gas AS. She has published several ten per-reviewed articles and has been the primary supervisor of 20 Ph.D. students. ▶

# ABSTRACT

## MY EXPERIENCE IN ENHANCED OIL RECOVERY RESEARCH:
## A Third of a Century Retold in a Third of an Hour

This talk is a quick tour of the EOR research at DTU. Starting with the first naïve steps leading through years of growing research activities in CERE with Danish and international partners. Going through cycles in the oil price, changing political agendas, and progress in science leading to the current situation. ▶

# BIOGRAPHY



**Erling H. Stenby, Head of the Chemistry Department at DTU**

Professor Erling H. Stenby is the Head of the Chemistry Department at the DTU, and the Scientific Director at the Center for Oil and Gas (DHRTC). He was a Director for CERE during twenty years (from 1994). He has an experience in research management of the large projects related to petroleum production, and a long experience in the research in enhanced oil recovery. E.H. Stenby been the Danish representative in the collaborative program on enhanced oil recovery organized by the International Energy Agency. ▶


COPENHAGEN MEETING
WEDNESDAY 23 NOVEMBER 2016

NOVEMBER

**PROGRAMME**
17:30 - 18:30
DRINKS

18:30 - 19:30
PRESENTATION AND SPE NEWS

19:30 - 21:00
DINNER

**LOCATION**
DTU
Auditorium 101 B and
DTU Faculty Club (dinner)
Anker Engelundsvej 1
2800 Kgs. Lyngby

**SPEAKERS**
Alexander A. Shapiro,
Kaj Thomsen and
Ida L. Fabricius, DTU

**TOPIC**
Particles in pores: Enemies and friends, Mineral precipitation from brines, What makes chalk stick together

**DINNER SPEAKER**
Erling H. Stenby, DTU

**TOPIC**
My experience in enhanced oil recovery research: A third of a century retold in a third of an hour

**ENTRANCE FEE**
None

**REGISTRATION**
Please indicate your attendance by Thursday 17 November by signing up on the internet
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# SPE MEETING SCHEDULE 2016-2017

| September 22 | MAIN SPEAKER | AFTER DINNER |
|---|---|---|
| TOPIC | **Brent Decommissioning - Next steps** | |
| SPEAKER | Duncan Manning, Shell | |
| LOCATION | Charlottehaven | |
| SPONSOR | Shell | |
| **October 26** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | **Human Factors in Barrier Thinking** | Optimized well design for shallow reservoirs.<br>*Speaker: Johnny Bårdsen, Welltec* |
| SPEAKER | Ronald McLeod (SPE DL) | |
| LOCATION | Welltec | |
| SPONSOR | Welltec | |
| **November 23** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | **Particles in Pores: Enemies and Friends**<br>**Mineral Precipitation from Brines**<br>**What Makes Chalk Stick Together** | My Experience in Enhanced Oil Recovery Research: A Third of a Century Retold in a Third of an Hour.<br>*Speaker: Erling H. Stenby, Head of the Chemistry Department at DTU* |
| SPEAKER | Alexander A. Shapiro, Associate Professor at CERE<br>Kaj Thomsen, Associate Professor at CERE<br>Ida L. Fabricius , Associate Professor at CERE | |
| LOCATION | DTU | |
| SPONSOR | DTU | |
| **January 25** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | **How can Microfracturing Improve Reservoir Management?** | South Arne – Ocean Bottom Seismic.<br>*Speakers:*<br>*Christian Rau Schiott, Hess*<br>*Marianne Rosengreen, Hess* |
| SPEAKER | Mayank Malik (SPE DL) | |
| LOCATION | Moltkes Palæ | |
| SPONSOR | Hess | |
| **February** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | | |
| SPEAKER | | |
| LOCATION | Maersk | |
| SPONSOR | Maersk | |
| **March 14** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | | OPTION<br>*Speaker: Stefan Glimberg, Lloyd's Register* |
| SPEAKER | | |
| LOCATION | DONG | |
| SPONSOR | DONG | |
| **April** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | **Shale Gas Evaluation** | |
| SPEAKER | Niels Schovsbo, GEUS | |
| LOCATION | GEUS | |
| SPONSOR | GEUS | |
| **May 23** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | **Creating Value from Uncertainty and Flexibility** | AGM |
| SPEAKER | Reidar B. Bratvold (SPE DL) | |
| LOCATION | | |
| SPONSOR | Chevron | |
| **June** | **MAIN SPEAKER** | **AFTER DINNER** |
| TOPIC | **SPE Summer party** | |
| SPEAKER | | |
| LOCATION | | |
| SPONSOR | Schlumberger | |

# SPE Copenhagen Student Scholarship – 2016

*Hadise Baghooee, awarded the prestigious SPE Copenhagen Section Student Scholarship.*

We're delighted to announce that Hadise Baghooee was awarded the prestigious SPE Copenhagen Section Student Scholarship.

Hadise, who now holds an MSc in Petroleum Engineering, completed her thesis with the title of "propagation of the liquid-liquid interface in a two-phase flow in a porous medium" at the Center for Energy Resources and Engineering (CERE) under supervision of Alexander Shapiro. She also holds a BSc in Petroleum Engineering (Reservoir) from Shiraz University, Iran. She was awarded the IGU young professional sponsorship upon presenting her B.Sc. work in the IGRC2014.

During her tenure as the membership chairperson of the SPE Student chapter (2015-2016), Hadise promoted the organization and held several recruiting events. As a result, the chapter saw a two fold increase in the number of active members.

Hadise is interested in Reservoir Engineering and Reservoir Simulation and she plans to continue her career in the oil and gas industry through graduate program or a research position that fulfills her interests.


## Contact information:

**E-mail: hbaghooee@gmail.com**




# SPE Young Professionals

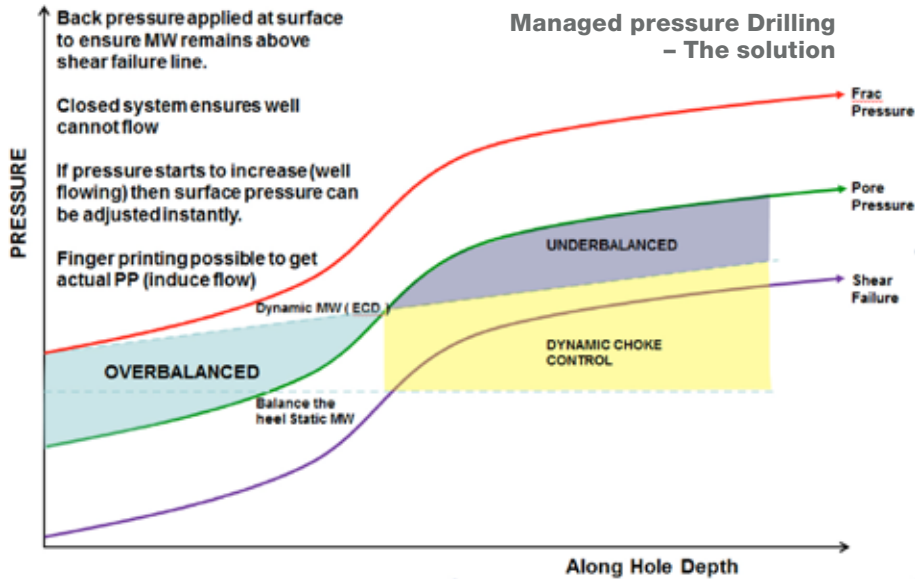
Please join the YP event at Nørrebro Bryghus 6th of December 2016 from 5-7 PM. The talk will provide a high level overview of the development of Halfdan including the learnings related to horizontal wells and high rate water injection that were piloted in the Dan Field. Highlights from the Halfdan development includes line drive utilizing long horizontal wells and the FAST technology where the injector wells were stimulated by controlled water injection fracturing. Presenting this evening is Lars Malcolm Pedersen, Halfdan Reservoir Manager.

**If you would like to participate in the event, please sign up by writing to Mhansen4@slb.com**

# MANAGED PRESSURE D IMPROVES SAFETY AND

By Mike Vander Staak and Mark Jerrard, Hess Corporation

**There's a lot to like about managed pressure drilling (MPD). It creates new options for drilling technically challenging wells while enhancing safety and reducing environmental risk. all that while minimizing non-productive time.**




Consider a typical drilling envelope, as illustrated in Figure 1. To be successful, a drilling team must operate within pressure boundaries remaining below the formation's fracture pressure (the hydrostatic pressure that causes the formation to breakdown) and above the shear pressure (the lower limit, to avoid formation instability and subsequent collapse which can increase the possibility of an influx of fluids and/or loss of the hole section). This is accomplished during a conventional drilling operation by using the time-consuming practice of adjusting mud density. Comparatively, MPD offers a step change in performance because it can instantaneously and precisely control bottom hole pressure and balance circulating pressure at any point in the annulus. This means that drillers can both apply and reduce choke pressure at surface to control a "dynamic" equivalent circulating density at any point in the wellbore.

This controllability is an especially important benefit in deepwater environments such as the Gulf of Mexico, where engineers have historically struggled with maintaining drilling margins for mud weight that avoid losses, maintain hole stability and prevent an influx of formation fluid. Any undesired influx during the MPD operation can be safely and accurately contained, minimized and controlled with certified equipment as part of the primary well control barrier envelope.

Hess has observed these benefits firsthand from successfully using MPD during drilling campaigns in chalk reservoirs as part of the Phase 3 expansion of the South Arne oil field in the Danish North Sea. Hess has also used MPD on the Semai 5 drilling project, an exploration drilling program to appraise multiple prospects in deepwater offshore West Papau, Indonesia. Additionally, Hess is actively applying aspects of controlled pressure drilling in the Bakken, Utica and, previously, in Kurdistan.

So what makes MPD so appealing offshore? The answer lies in precision and control. In fact, the IADC—the International Association of Drilling Contractors—defines MPD as "an adaptive drilling process used to precisely control the annular pressure profile throughout the wellbore." The intention of MPD is to control pressure, avoid influxes of formation fluids to the surface ("kicks"), and prevent fluid losses into the formation that can potentially damage the well.

This is especially important in deepwater wells, where the challenge of controlling wellbore pressure is greater than in shallow wells. Understanding the wellbore helps drillers determine the safest and most effective operations for the project. It allows the team to check and adjust while drilling in real time. It is a very efficient way to continually learn and improve performance and safety.

# RILLING EFFICIENCY

In conventional drilling, the deeper the well, the more time consuming and difficult it is to change the fluid density. The more efficiently and timely the wellbore pressure can be managed, the lower the potential for significant non-productive time and safety risks to workers and equipment. MPD addresses such factors that impact wellbore pressure as controlling formation pressure and maintaining wellbore stability without exceeding fracture pressure of the rock (see Figure 1). Typically, in primary well control, mud weight plus friction is used to provide an Equivalent Circulating Density (ECD), while with MPD, the driller is able to manipulate surface back pressure. MPD allows the driller to immediately affect the bottom hole pressure by adding or reducing that applied backpressure.

*"MPD offers a step change in performance because it can instantaneously and precisely control bottom hole pressure and balance circulating pressure at any point in the annulus."*

Some MPD systems allow the driller to manage pressure all the way along the annulus. So if the operation drills into a permeable zone and influxes are observed, the bottom hole pressure can be manipulated very quickly and effectively to minimize the magnitude of the influx. Rather than having to stop the drilling operation, the driller can adjust the effective bottom hole pressure to a higher mud weight within seconds. A rapid response to gain control of fluid influx provides a tremendous safety advantage for MPD during the drilling operation.

Hess is capitalizing on lessons learned about managed pressure drilling onshore and during drilling of conventional offshore wells as it moves the technology into deep waters. Among the important lessons learned are:

- **Choose the right vendor: Focus on the vendor whose operation is fit for purpose and has a good track record in safety and environmental performance, not necessarily the least expensive**
- **Ensure the vendor team is engaged and properly staffed with experienced personnel**
- **Invest time, energy and money on training for the office and rig-based teams to ensure everyone is aligned, knows what to expect and what specific drilling and safety practices are required**
- **Encourage cross-departmental collaboration (sub-surface, operations, drilling, engineering, safety, etc.) to advance a sense of ownership, confidence and engagement**
- **Make sure the team leads and management on the operator side are passionate about MPD technology in order to successfully engage key stakeholders**

# ABSTRACT

# HOW CAN MICROFRACTURING IMPROVE RESERVOIR MANAGEMENT?

Microfracturing is an excellent method of obtaining direct stress measurements, not only in shales but also in conven¬tional reservoirs. Recent advances have shown that micro¬fracturing can help improve reservoir management by guiding well placement, completion design, and perforation strategy. Microfracturing consists of isolating small test intervals in a well between inflatable packers, increasing the pressure until a small fracture forms and, by conducting a few injection and shut-in cycles, extending the fracture beyond the influence of the wellbore. This talk describes the microfracturing process and presents several examples that led to increased hydro¬carbon recovery by efficient stimulation and/or completion design. Case studies presented range from optimizing hydrau-lic fracturing in unconventionals, determining safe waterflood injection rates in brownfields, and improving perforation placement in ultradeepwater reservoirs. ▶

# BIOGRAPHY

**Mayank Malik, Global formation testing expert at Chevron**

Mayank Malik is the global formation test¬ing expert at Chevron Energy Technology Company and is a champion for advancing research on microfracturing. He holds a BS degree in mechanical engineering from Delhi College of Engineering, an MS degree in mechanical engineering from University of Toronto, and a PhD in petroleum engineering from the Uni¬versity of Texas at Austin. Malik has authored numerous papers on petrophysics, formation testing, and microfracturing. He serves on the SPE Reservoir Description and Dynamics advisory committee and is the chairman of the SPWLA Formation Test¬ing Special Interest Group. ▶

# ABSTRACT

## South Arne – Ocean Bottom Seismic

Hess has a long history of using 3D and 4D streamer seismic data (1995, 2005, 2011) to support reservoir modelling, well planning and well interventions at the South Arne field . While the seismic image quality in general is very good, a gas cloud in the overburden greatly deteriorates the image underneath, to the point where the conventional streamer seismic image cannot be used for structural and stratigraphic interpretation.

To overcome this challenge, Hess in 2014 acquired an Ocean Bottom Seismic (OBS) survey over the field. The OBS project had several objectives, including

- Improving the image in the gas cloud obscured area for structural and stratigraphic interpretation using both PP and PS data
- Serve as a base line for future 4D OBS
- Optimize further field development

This presentation will highlight how the OBS data was interpreted and integrated into the structural framework, and how the new information is used to support reservoir modeling and reduce risk and uncertainty in further field development. ▶

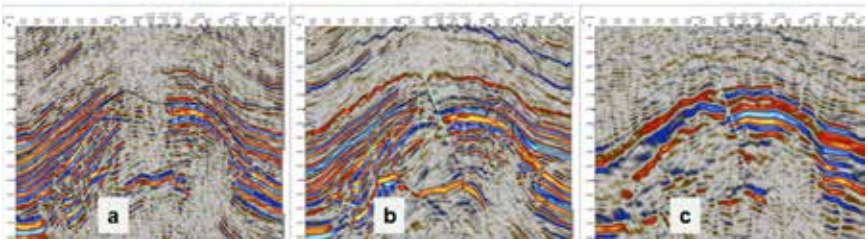



*Figure 1 Seismic image at reservoir level. Panel a shows streamer data, panel b shows PP OBS data and panel c shows PS OBS data through the gas cloud obscured area. A major normal fault is revealed under the gas cloud.*

# BIOGRAPHY

**Christian Rau Schiott,**
**Geophysical Advisor, Hess**

Christian has 15 years of industry experience from North Sea, Malaysia, GOM, West Africa and Australia. He has mainly worked on reservoir characterization and uncertainty modeling, seismic inversion and time lapse (4D) seismic. ▶

**Marianne Rosengreen,**
**Senior Geophysicist, Hess**

Marianne Rosengreen has 18 years of experience working with seismic data and reservoir characterization. She has been working for Hess since 2012 and was previous working for Schlumberger and Ødegaard. ▶

COPENHAGEN
MEETING
WEDNESDAY 25 JANUARY 2017

JANUARY

**PROGRAMME**
17:00 - 18:00
DRINKS

18:00 - 19:00
PRESENTATION AND SPE NEWS

19:00 - 21:00
DINNER

**LOCATION**
Moltkes Palæ
Dronningens Tværgade 2 A
1302 København K

**SPEAKER**
Mayank Malik, SPE DL

**TOPIC**
How can Microfracturing Improve Reservoir Management?

**DINNER SPEAKERS**
Christian Rau Schiott and Marianne Rosengreen, Hess

**TOPIC**
South Arne – Ocean Bottom Seismic

**ENTRANCE FEE**
None

**REGISTRATION**
Please indicate your attendance by Thursday 19 January by signing up on the internet www.spe-cph.dk

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