DrillWell

DRILLING AND WELL CENTRE
FOR IMPROVED RECOVERY

ANNUAL REPORT 2018

NORCE SINTEF Universitetet i Stavanger NTNU

Centre for Research-based Innovation

The Research Council of Norway

DrillWell

DRILLING AND WELL CENTRE
FOR IMPROVED RECOVERY

About DrillWell

DrillWell (The Drilling and Well Centre for Improved Recovery) was appointed the status of a Centre for Research Based Innovation (SFI) by the Research Council of Norway in 2011. NORCE is the host, with SINTEF, UiS and NTNU as research partners. The Centre has four industrial partners; Equinor, Wintershall, ConocoPhillips and Aker BP. DrillWell is an industry-driven collaboration and innovation environment. The industrial partners prioritize and direct the R&D effort towards particular challenges. The Centre is an active proof of Stavanger and Trondheim joining forces together with the international oil and gas industry.

The annual budget for 2018 was approximately NOK 47 million. NOK 10 million was granted from the Research Council of Norway, and the industry partners contributed with a total of NOK 22 million. In addition, NOK 11 million was funded by the Research Council for three PETROMAKS2 projects together with industry funding from DrillWell and NOK 4 million was funded by the research partners. One international partnership project (INTPART) with US partners in Texas was also funded by the Research Council.

A total of fifty researchers, five professors, six PhD candidates, four Post Docs and twelve graduated MSc students have contributed to the Centre activities in 2018. This has resulted in 17 journal papers and 21 additional publications plus several keynote speeches and popular publications. Prototype software for drilling process optimization has been tested by participating oil companies. The Centre organizes one large seminar annually and distributes the DrillWell Newsletter.

CONTENT

DRILLWELL 2018

As DrillWell is being finalised in 2019, the main emphasis is on maturing results and producing deliverables. An example is the application of software developed in our drilling process optimization project. This is used by Sekal to assist Equinor for automated drilling control on semi-submersible drilling rigs and for a number of oil companies to monitor drilling operations.

Prototype software for drilling process optimization has also been installed at oil company offices for testing and application, and there is dialogue with service companies for implementation and commercialization of useful models and knowledge.

The R&D work within our four focus areas Drilling Process Optimisation, Well Control, Well Integrity and Plugging and Abandonment of wells, is aiming for improved safety and cost reduction, thus contributing to economic development of new prospects and to keep mature fields in operation.

Our main results are presented at international conferences and in journal papers. In phase two we have succeeded in increasing the number of journal papers. Six PhD students and four post docs are engaged, and twelve master students contributed in 2018 through their thesis work.

During 2018 full-scale experiments on cement placement in wells with washout have been evaluated using computer models developed in DrillWell. Full scale cells are available for testing of innovative technology for well barrier evaluation and have been used for testing new technology before offshore application.

Competence and technology developed by DrillWell has been essential for establishing spin-off projects within geo-steering, real-time drilling data acquisition and processing, drilling geo-thermal wells and multi-phase phenomena in complex fluids, the last one being part of the PIRE programme (Partnership for International Research and Education).

Our international cooperation with eight universities includes four in Texas, two in Canada and two in France. A one-day workshop within Digitalisation was arranged in Houston with the INTPART NorTex Data Science Cluster project.

The annual seminar arranged at Sola in Stavanger had broad participation from oil companies, service companies and researchers, giving a good setting for presenting and discussing recent results. Presentations included front end technology from service companies and challenging operations from the oil companies as well as high quality R&D results, which turned out to be very successful.

Including three Petromaks2 funded spin-off projects, the centre budget is around NOK 47 million per year in the second phase which will last until autumn 2019. Discussions are ongoing with the participating oil companies regarding planning for a Phase 3 with industry funding from a larger group of oil companies and with the involvement of service companies.

Sigmund Stokka

Sigmund Stokka
DrillWell Manager, NORCE

DrillWell
DRILLING AND WELL CENTRE
FOR IMPROVED RECOVERY

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Drilling and well centre for improved recovery

VISION

Unlock petroleum resources through better drilling and well technology.

OBJECTIVE

Improve drilling and well technology providing improved safety for people and the environment and value creation through better resource development, improved efficiency in operations and reduced cost.

Cost reduction
Innovative drilling and well technology is needed to reduce exploration and development costs, as well as well plugging and abandonment.

Improved recovery
Improved wells at lower cost will imply higher recovery of oil and gas by increasing the number of wells and their productivity.

Efficient field development
Improved wells at lower cost will imply cost-efficient field development. Today wells represent around 50 percent of the field development cost.

PEOPLE IN DRILLWELL

BOARD

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ConocoPhillips

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Wintershall

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NTNU

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UiS

Helga Gjeraldstveit
NORCE

SCIENTIFIC ADVISORY COMMITTEE

In 2015 DrillWell established a Scientific Advisory Committee (SAC). The Committee is comprised of international experts within drilling and well technology that cover the scope of work carried out in DrillWell.

- *The main task of the SAC is to advise and evaluate the scientific performance of DrillWell in relation to the Centre's vision, objective and research plans including PhD projects. The SAC will meet with the Centre's Management Team and Project Leaders once a year. Between meetings, the Centre Director is encouraged to seek advice from the SAC on important decisions relating to the scientific performance of DrillWell, especially for PhD projects.*

Representatives from SAC attended the DrillWell seminar in September 2018 and contributed with their knowledge and experience.

After the seminar, SAC and the DrillWell management team had a separate meeting in Stavanger. John Thorogood commented that there was a good balance between presenting selected R&D results and allowing the industry to present related technology and developments. Scientific progress, deliverables from DrillWell and scientific production were also on the agenda. The SAC reviewed highlights from research within Drilling process optimization, Drilling process control, Gas solubility in oil based mud, Well control simulation, Cement integrity, Geopolymer material, Full scale cementing experiments and Well barrier evaluation.

The following international experts are members of SAC:

JOHN THOROGOOD
DRILLING ENGINEERING ADVISOR AT DRILLING GLOBAL CONSULTANT LLP

Following 34 years with BP, now an independent consultant with 46 years industrial experience in drilling engineering and operations. Activities include advisory roles to operators on management systems, frontier exploration projects in deep water and remote areas, shale gas operations, process safety, well control and forensic reviews of operational problems, development and implementation of new technology and R&D programme management.

KITT ANITA RAVNKILDE
PRINCIPAL PROGRAMME MANAGER, DANISH HYDROCARBON RESEARCH & TECHNOLOGY CENTRE, DTU

Started her engineering career with Maersk Oil and later DONG E&P holding various positions related to Drilling and Production Technology over a period of 25 years. In April 2015, she joined the research centre DHTRC at DTU. The work involves building up a framework for international research and to lay the foundations for relevant, research-based study programmes with the potential to support interdisciplinary and interdepartmental research programmes. The overarching purpose is to identify new technological and conceptual solutions that boost oil and gas extraction in the Danish section of the North Sea.

ANDREW K. WOJTANOWICZ
TEXACO ENVIRONMENTAL CHAIR AND PROFESSOR IN THE CRAFT AND HAWKINS PETROLEUM ENGINEERING DEPARTMENT AT THE LOUISIANA STATE UNIVERSITY

Has held faculty positions at the New Mexico Institute of Mining and Technology and the AGH University of Science and Technology in Krakow, Poland. He is a UN expert in drilling engineering and has worked for the oil industry as a drilling engineer, drilling supervisor, and drilling fluids technologist in Europe and Africa.
His studies have been reported in 206 publications and eight books. He was Conoco Environmental Fellow 1990-91, served as Editor-in Chief of ASME Transactions Journal of Energy Resources Technology from 2000 to 2011, was SPE Distinguished Lecturer 2003-04, and received several awards from SPE and ASME.

DRILLWELL ORGANISATION

INDUSTRY PARTNER PERSPECTIVES

Fredrik Varpe Equinor

The results from the DrillWell SFI have contributed to improved drilling process quality. Prototype tools for assisting the operational drilling process control, developed during the first phase of the programme, have been tested and implemented in existing systems used by the industry partners. Through industrialization and commercialization of the applications, the results of the SFI work is becoming visible with several examples of high value creation for DrillWell members. We are now well into phase 2 of the programme and many of our PhD candidates are finalizing their work. It is important that we ensure that the scientific communities of DrillWell deliver on their academical objectives, remain strong and able to serve the Norwegian oil and gas industry beyond the duration of the programme.

Rune Woie ConocoPhillips

The DrillWell program is approaching its end and several of the projects and activities are into validation testing, closing phase or already completed. Some projects have moved to industrialization or possible extension through new programmes. For the finalization of DrillWell, it becomes important that project activities and documentation are completed within the deadlines for evaluation of their continuation. It is still the industry, oil companies, contractors or service vendors, that will derive value from the outcome and move the quality work forward.

This completion and interaction with industry is challenging but necessary to realize the basic and successful research performed over many years. It must be noted that improved HSE and effectiveness with cost reductions are still needed and welcomed by the industry.

Knut Sigve Selnes Aker BP

The DrillWell programme has successfully delivered research and development projects that have improved the understanding of important mechanisms in well construction and abandonment. Several of these have resulted in spin-off projects that have developed or aided the development of significant drilling and well technologies that will increase efficiency, reduce cost and better the quality of our operations. In particular the DrillWell programme has contributed significantly in our effort to digitize our processes and improve our ability to abandon our wells in a safe and effective manner. The DrillWell programme has also been a successful venue for cooperation between several of the largest operators on the Norwegian shelf and several of the largest universities and research institutions in Norway.

Torgeir Larsen Wintershall

The R&D programme in DrillWell addresses some key challenges within drilling and well technology. It is a strong consortium between the main operators on the NCS and the R&D partners NORCE, SINTEF, NTNU and UiS. For Wintershall it is important that DrillWell produces results and solutions that are useful for the industry. We want to see new solutions that can reduce operational cost and the cost of P&A significantly. The centre has over the last period produced promising results enabling more efficient and predictable operations.

INDUSTRY PARTNERS

equinor ConocoPhillips AkerBP wintershall

Foto: Yngve Olsen Sæbbe

Songa Enabler at Olavsvern in Tromsø.

Bringing research into the industry

In 2018, DrillWell research and technologies were adopted by the oil and gas industry, with growing interest in the DrillTronics automated drilling system, as well as enthusiasm for our cuttings transport model, well barrier evaluation techniques and displacement modelling for primary cementing. We also began planning for a new paradigm, when DrillWell will be funded only by the industry.

FURTHER DEVELOPMENT OF DRILLTRONICS TECHNOLOGY

After the successful implementation of Drilltronics software by DrillWell on the semi-submersible rig Songa Enabler in the Barents Sea in 2017, the technology has been further improved and preparations have been made for installations on eight rigs in 2019.

The software automates drilling process control and enables drillers to optimize and enhance the safety of their drilling operations. In the case of the Songa Enabler, "there were some challenges that were identified very early on due to this technology," says Equinor's Fredrik Varpe, who is DrillWell Chairman of the Board. "Meaning measures could be taken to avoid further escalation, regain control of the drilling process and avoid redrilling a section of the well."

The software helped save an estimated 100 million NOK, providing the proof of concept needed to precipitate wider adoption, with eight cutting edge rigs now poised to implement the technology.

"Showing that we can contribute to better and cheaper drilling is very positive for DrillWell," says DrillWell Manager Sigmund Stokka. "We need to show that we are useful for the industry. And we are."

OPTIMIZING THE CUTTINGS TRANSPORT MODEL

DrillWell's work to improve the cuttings transport model in the well has also been beneficial to the industry, substantially limiting the number of sidetracks required in the drilling process. Working with Sekal, the DrillWell team has combined the cuttings transport model with other wellbore simulation models for optimizing well hydraulics during operations.

"If you understand how the cuttings are transported out of the well, you can adjust your mud choice and pump rates and optimize the process by selecting the best way to pump and clean the well," says Stokka.

DISPLACEMENT MODELLING FOR PRIMARY CEMENTING

Using computer modelling and automation to replicate and ultimately replace costly and labour-intensive mechanical operations is also proving an important differentiator as drilling moves into a more digital age.

The development of a 3D computational fluid dynamics model by DrillWell in 2018, continues this process. "It is very important that we understand the displacement process when we displace drilling mud with spacer fluid and cement," says Stokka. By verifying the 3D model

with full scale cementing experiments, DrillWell has demonstrated its robustness and put it in the frame for real world adoption.

WELL BARRIER EVALUATION

That real world adoption of DrillWell technology has already happened with the organisation's innovative technology for well-barrier evaluation that was first tested at the Ullrigg Test Centre.

"There are many tools to verify well barriers, such as testing whether the cement is tight, and these are very difficult to qualify," says Stokka. "You want to know that the cement is not leaking and that there are logging tools to verify this. We have built a full-scale test lab with similar conditions to what you would find offshore where this can be verified." The tested technology has now been successfully applied in an offshore well.

WELL PLUGGING AND ABANDONMENT

The evaluation technology is just one way in which DrillWell activities within cementing and well barrier evaluation have contributed to cost reductions in the industry in recent years. The development of software for leakage risk modelling in P&A also promises to be an important tool for cost reduction. The system applies a risk-based approach, common in many other parts of E&P, to plugging and abandoning wells.

"We have made a lot of progress in P&A and there have been gains made in efficiency. But we see that there is room for more solutions that could give us the functions we need at a lower cost," says Varpe. "If you cannot robustly verify the barrier then you have a challenge. A method using a leakage calculator is one approach because if you can justify that a barrier does not have leakage potential then that is good enough, and you can avoid the costly implementation of an unnecessary new barrier," he says.

With further cost reduction required to make sure offshore drilling in Norway remains competitive, leakage risk is regarded as an important avenue for further research once DrillWell moves beyond the present funding model (SFI) which involves the Research Council of Norway, in September.

BEYOND SFI

"We are starting a new phase for DrillWell with funding only from the industry. It will be by the industry for the industry," says Stokka. "Of course, this is a challenge, but it is also an opportunity. At the moment, we have a lot of long term projects. After September we will be able to work on short term requirements and deliverables. In this way, our work can be more visible to the industry and we can solve more of the short-term needs."

The new look model will resemble a triangle where, operators, services companies and academia, in the form of DrillWell, will all work together and reinforce each other. The seeds of this co-operation model were evident in the DrillWell seminar this year, which included presentations from researchers, oil companies and the service industry.

"We had presentations and discussions of topics supporting improved drilling and well operations, especially related to drill string wear, well control, well hydraulics and cementing," says Stokka. "It was very successful."

The next seminar will be held in September when the organisation will have transformed. Plans are being prepared to transfer DrillWell to an industrial centre for drilling and well innovation after the summer, focusing on Improved digital drilling and well solutions. Operators and service companies are invited to join to further develop and mature the technology.

Varpe sees a big opportunity in the analysis of the extra data emerging as drilling embraces more of a digital future. "The implementation of wired drill-pipe bringing broadband to the drill bit; high speed telemetry enabling us to include sensors that will give us a much better resolution of conditions in the well, these are going to bring a whole lot of new data. To fully utilize those data we need research on data driven decisions and smart functions that could give us a better representation of the well condition."

"For research, there is a big opportunity both in hardware – in sensors and so forth – and also in the usage of the data and extracting information. That room is very big and it is not thoroughly explored."

DRILLING DATA HUB

Whatever needs the industry requires of DrillWell, it is sure to include improvements in the retrieval and use of data. Through the Drilling Data Hub, the organisation continues to contribute to the establishment of a standard for acquiring and processing real-time drilling data where all data are stored in a unified system and can be accessed by different users.

"Today you spend 20% of your time testing your ideas on the data, and 80% of your time getting the data available," says Varpe. "If we have the right system in place, then we can flip that. That is why the Drilling Data Hub is so important."

Fredrik Varpe,
Chairman of the Board
Equinor

Sigmund Stokka
DrillWell Manager
NORCE

Jan Einar Gravdal,
Programme Manager

PROGRAMME 1:
Safe and efficient drilling operations for cost reduction

DrillWell's programme 1 continues to deliver technology that makes a difference for the drilling industry.

The activities in Programme 1 cover sensors, data acquisition, data analytics and fundamental research e.g. on drilling fluid properties. Some of the technologies have matured and during 2018 more statistical data have been gathered from drilling operations where DrillWell results have been implemented. A significant decrease in unwanted incidents resulting in non-planned technical sidetracks has been registered. Historically, more than 30 percent of all production wells drilled on the NCS in the period 2013-2016 resulted in a sidetrack. With use of DrillWell technology as part of a software commercialized through Sekal AS it is reported that after drilling more than 180 wells, less then 10% of the wells needed a technical sidetrack. DrillWell has therefore been one important vendor of technology that has contributed to cost savings in the order of 100s of millions of dollars.

A consequence of the successful enrolment of technology is that more people from the industry and academia has become aware of DrillWell and the fact that technology from the centre is being implemented with success. In 2018, the number of attendees for the DrillWell seminar as well as other DrillWell associated activities shows the increasing interest in the centre and its results.

In 2018, three projects have been run in Programme 1, one of these with additional funding from PETROMAKS2 at the Research Council of Norway.

Projects in Programme 1:

- Drilling Process Optimization (project manager: Eric Cayeux)
- Well Control Simulator (project manager: Knut S. Bjørkevoll)
- Pressure Ahead – Pressure Prediction Ahead of Bit With Uncertainties -KPN project (project manager: Ane Lothe)

Meet Marius Staahl Nilsen, Drilling Engineer

- My main hobbies are playing piano and weight lifting: piano for a healthy mind and weight lifting for a healthy body. Other than that, I enjoy cooking and eating delicious food with my friends and family, watching tv series and movies, playing video games and taking an occasional journey to somewhere exotic to explore a new destination and culture.

PROGRAMME 1

Name: Marius Staahl Nilsen

Age: 27

Nationality: Norwegian

Education: MSc in Drilling Engineering at the Norwegian University of Science and Technology

Department: Department of Geoscience and Petroleum, NTNU

What are you working on right now?
My main field of interest is the interaction between the formation gas and the drilling fluid during well control incidents. More specifically, how formation gas can be dissolved into an oil-based mud during a gas kick and then suddenly boil out of the liquid as the mud is pumped towards the surface. Earlier experiments have shown that the boiling of gas is not an instantaneous process, and that there is a time delay before all the gas is released from the liquid. So right now, I am designing and building apparatus with the intent to measure how fast gas is liberated from an oversaturated liquid.

Why do you find this interesting?
I have always had a curious mind, especially when it comes to natural phenomena and why things work as they do, so I find most science-y things interesting. However, the motivation behind this specific work is to better understand the gas-liquid interaction during well control incidents in order to enhance the predictions of what may go wrong during drilling operations. I hope that my work can help to make the drilling process even safer for the people involved and the surrounding environment.

You work in close collaboration with the oil and gas industry, would you say this adds any extras to the project?
Indeed! I think that great ideas can be born when academia and industry work together and share experiences and knowledge with each other. On the academic side, we have people with high quality and up-to-date knowledge in their respective fields, and the industry partners with real-life experience of how things actually work. The collaboration also increases the chance that my work will actually be put to use in the industry instead of being abandoned and forgotten at some university library.

Do you see yourself working within oil and gas in ten years' time? If yes, doing what?
It is difficult to predict where I will be and what I will do in 10 years' time. Right now I am focusing on finishing my PhD. Maybe I will stay in academia, maybe I will start working in the industry. Maybe I will stay in the petroleum industry, maybe I will do something completely different. I am open for every opportunities that I get, and I have to evaluate them as they appear. But I can definitely see myself working as a researcher. But where and within what field?
Only time will tell!

Eric Cayeux
Chief Scientist at NORCE
and project manager of
Drilling Process Optimization

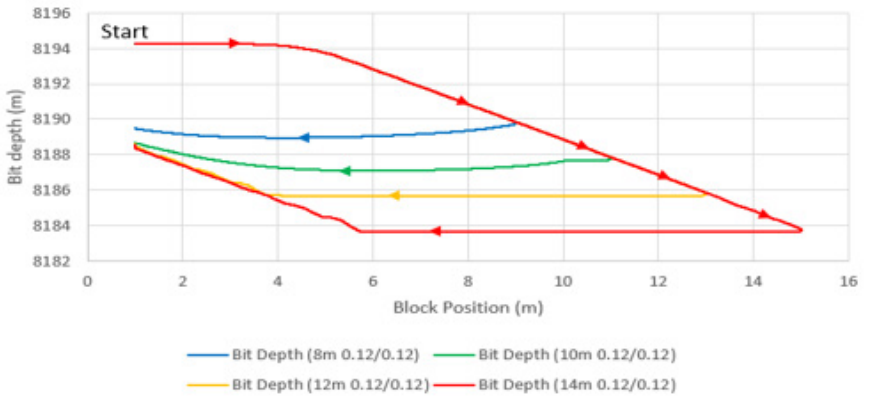
PROGRAMME 1

Drilling process optimization

In 2018 work started to couple the transient axial and torsional mechanical model developed in DrillWell, with an advanced transient hydraulic model, creating the world's most accurate hydro-mechanical model. The combined model accounts for hydraulically induced forces on the drill string, mechanical friction, the physics of the hoisting and top-drive systems and bit rock-interactions, as well as multiphase flow behaviour of the drilling mud.

With its real-time capabilities, the transient hydro-mechanical model will have many applications and potentially contribute significantly to reduced drilling costs. One application is to improve procedures executed during drilling, such as friction tests. Friction tests are necessary to check the quality of the borehole when drilling a well. The information that can be extracted from a friction test relies very much on how the test has been executed.

The transient hydro-mechanical model allows one to revisit problems that have been experienced while drilling extended-reach wells, for example the Gyda well by Talisman/Repsol, and Stafjord C16A by Equinor. When drilling these wells, it was impossible to perform successful friction tests because the slack-off weight never stabilized. A friction test corresponding to the end of the 8 ½-in section of the Gyda ERD well has been analysed using the transient hydro-mechanical model. Results from DrillWell show that even though the pick-up weight stabilized after pulling the string for about 4 meters, a stable slack-off weight could not be obtained without having a minimum displacement of 12 meter. This explains why the friction test was unsuccessful since the driller stopped the upward movement too early to enable a successful stable slack-off weight reading. The results point to the fact that it is possible to analyse beforehand the conditions by which a friction test at a certain depth can be successful. When implemented, this technology can contribute to optimizing the time spent on friction tests and improve their quality. A direct consequence of this is a more efficient drilling operation and yet another important piece of the puzzle towards enabling autonomous drilling.



Reconstruction of friction tests in an ERD well made with the transient hydro-mechanical model. When the driller stops the hoisting too early, a steady slack of weight can not be obtained since the entire drill string is not moving steadily.

PROGRAMME 1

Well control simulator

Well control incident in the North Sea vs. advanced gas influx modelling: Going through recordings for three days of field operation, where much of the time was spent on well control, gave researches a great push towards elevating the usability of theoretical modelling for analysing real well control incidents.

Comprehensive data on wellbore, running string, drilling fluid, reservoir fluids and operations was provided by the operator, and additional information, experience and views were shared in discussion meetings. This gave the researchers a chance to gain a better understanding of the operation. Combined with advanced calculations, this provided insight into both the determination of reservoir pressure and the subsequent sequence of well control operations. This article focuses on the overall picture, while additional data is sought to get a better grip on the finer details.

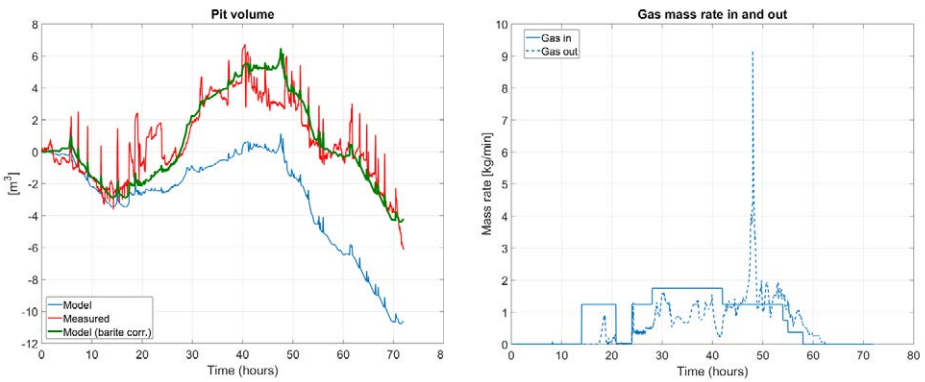
A well control simulator with new sub-models for kinetics and PVT calculations developed in DrillWell was used to mimic the whole three-day sequence. The main success criterion for this work was how well the simulated active pit volume matched the observed active pit volume from the dataset. The first simulations were far off in several respects, and a practical work procedure was developed to get a better understanding and better match between simulations and pit volume recordings.

One of the steps was to select the gas inflow rate from the reservoir as input rather than relying on the built-in reservoir model. This way an investigation of variations in permeability along the well due to heterogeneities and small fractures as well as minor differences in calculated and actual well pressure, could be done separately at a later stage.

In searching for a good match, researchers realized that the increase in drilling fluid volume due to the addition of barite and other dry materials was as large as around 8 m3 in total, which had to be added to the simulations by making use of mud logger's notes; refer to the green line in the figure below.

Another feature that turned out to be significant for this well was the marked increase in reservoir pressure with depth. This could make it a good case for verifying the PressureAhead concept, targeting pressure prediction ahead of bit.

While the overall picture is now good, there are deviations at a finer scale. Some of these are due to known effects that are not included in the model, like filling and emptying of surface lines as flow starts and stops, while others are less obvious. However, before delving more into such details, researchers aim to learn from additional incidents. This will serve to generalize and increase confidence in the methodology for incident analysis, and to identify key factors for alleviating well control incidents.



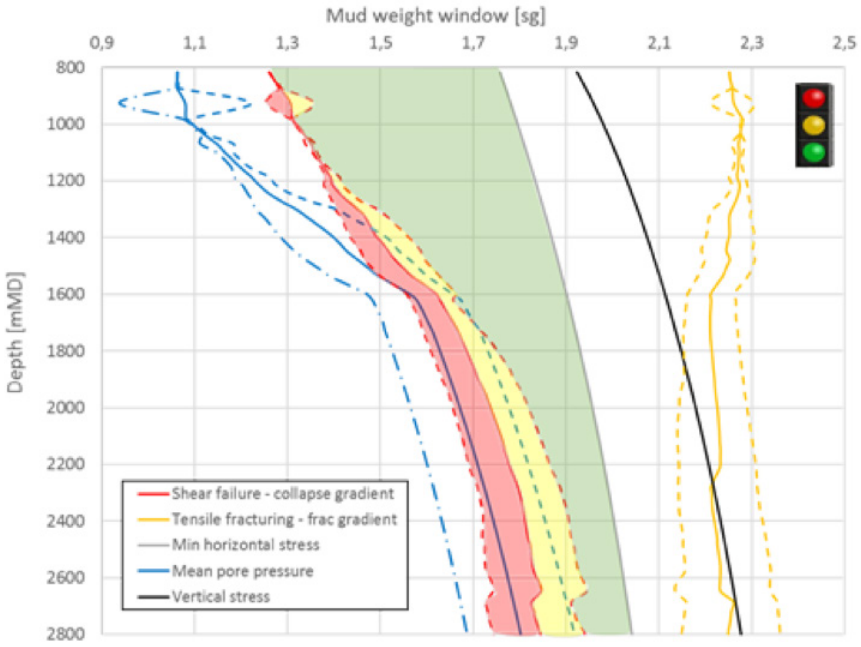
Left: Pit volume; measured (red) and simulated without (blue) and with (green) barite volume compensation. Right: Modelled gas influx rates (solid) and gas mass rate out of well (dashed). Gas influx slows down and eventually stops from approx. 42 until 58 hours.

Pressure Ahead

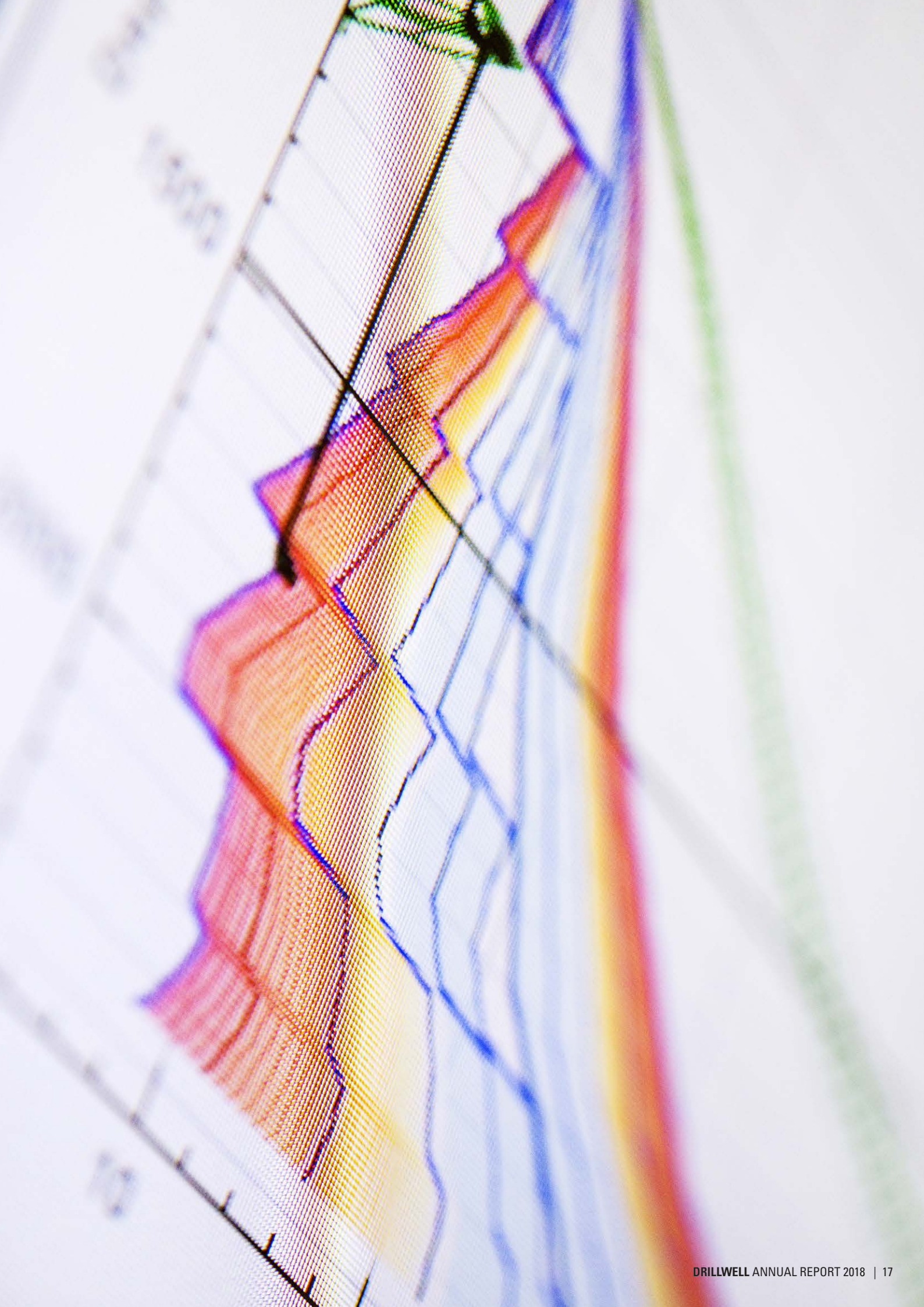
The PressureAhead project introduces new methods to reduce the uncertainties in geo-pressure prediction ahead of the bit. With better constraints on the pore pressure in the underground, it is easier to select the correct mud-weight while drilling and this will result in cost reduction and safer drilling campaigns.

Wrong assumptions regarding pressure and mud weight, may lead to non-productive time due to mud loss, stuck pipe and well control incidents. In this project the objective is to reduce the uncertainty in predictions of overpressures and mud window ahead of the bit. Since the input data is uncertain and our understanding of the processes is limited, thousands of simulations are carried out to simulate the most likely pressure profile. Thereafter, the most likely mud weight window along the planned well path is generated. We aim to update pressure prognosis and mud window by using available real-time drilling data from logs to improve predictions ahead of the drilling bit.

The project started in 2016, and will end early 2019, the PhD student financed by the project will finalize in December 2019. The new fast 3D pressure simulator will be further tested on a dataset from Alvheim, North Sea. Sensitivity on the input data for pore pressure and mud-weight window prediction will be further studied. A spin off single project for AkerBP has started where the whole workflow will be tested and validated real-time on a pilot well in the North Sea.



Traffic light showing a safe drilling window using the collapse gradient and the minimum horizontal stress as guide lines. Blue graph shows mean pore pressure gradient, with minimum pressure gradient (stippled line), and maximum gradient (stippled and dotted lines). Red graph shows collapse gradient with min (stippled graph) and max (stippled and dotted graph), and yellow show fracture gradient with min (stippled and dotted line) and maximum gradient (stippled line). From Lothe et al. submitted.



Torbjørn Vrålstad,
Programme Manager

PROGRAMME 3:
Well solutions for improved recovery

Ensuring well integrity is important to prolong well lifetime and to minimize leakages to the environment. DrillWell's Programme 3 is contributing significantly to achieve this.

In 2018, we have made good progress in all projects and we are improving our understanding of well barriers and well integrity. Important new insights have been found within cement integrity and placement, barrier evaluation technology and acceptance criteria.

As DrillWell is now approaching its end, our closeness and good dialogue with operators, major service companies and smaller, more technology-specific vendors are more important than ever. This ensures that our findings and deliverables are implemented and used by the industry. We are hoping that results from DrillWell will contribute to improved well integrity for all future wells.

There are four ongoing projects in Programme 3, where two of these are KPN projects with additional funding from PETROMAKS2.

Projects in Programme 3:

- P3.2 Life cycle cement integrity (Project manager: Torbjørn Vrålstad)
- P3.5 KPN Cementing irregular wellbore geometries (Project manager: Hans Joakim Skadsem)
- P3.6 Technologies for barrier evaluation and P&A (Project manager: Dave Gardner)
- P3.7 KPN Leakage risk assessment for plugged and abandoned oil and gas wells (Project manager: Eric Ford)

Meet Shreyansh Divyankar, researcher at UiS

- I would like to see the results of my study implemented and used in a real life setting.

PROGRAMME 3

Name: Shreyansh Divyankar

Age: 32

Nationality: Indian

Education: Bachelor of petroleum engineering from the University of Petroleum and Energy Studies, Dehradun. MSc in Petroleum Engineering from University of Stavanger.

Department: Department of Energy and Petroleum Engineering, University of Stavanger

What are you working on right now?
I am working on visualising flow phenomena and studying the flow of non-Newtonian fluids in a labscale duct that represents an irregular well-bore geometry. The goal of the research is to better quantify circulation efficiency during e.g. mud conditioning in preparation of primary cementing.

Why do you find this interesting?
Fluids used during well construction often have complex flow behaviour and this affects the flow of these fluids in realistic well-bores. The field methods used at the moment are primarily volumetric, which measures how much you pump and how much you return to the surface. But because there are expansions and contractions in the bore hole, and because the fluid flow behaviour is complex, it is interesting to see, or to recreate, how these flow phenomena affect the well in a lab set-up and recreate, isolate and study these effects one by one. This is the crux of my project.

How do you think this will have applications in the industrial world?
Proper mud conditioning is an important step for preparing the well for primary cementing. Poor conditioning is linked to a risk of residual drilling fluid that can compromise zonal isolation. We have found some unconventional results. Conventional wisdom says the faster you pump the better the circulation will be. But if we look at irregular geometries, this does not hold true. I think this finding could be transformative.

Do you see yourself working in oil and gas in 10 years' time? If so, doing what?
I would definitely like to stay within oil and gas. I worked as a petroleum engineer after I finished my bachelor for four years. I would like to see the results of my study implemented and used in a real life setting. If the operator knows before cementing is done that they are working with an irregular geometry in the bore hole, with my work, they will be able to correctly asses the flow rate and implement certain other remedial measures.

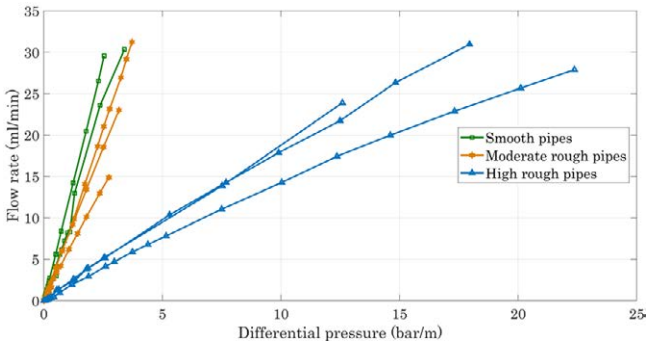
PROGRAMME 3

Life-cycle cement integrity

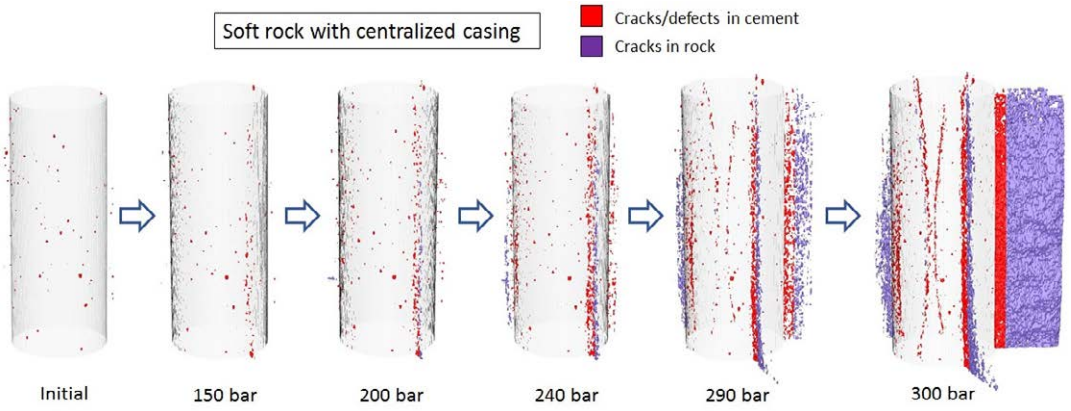
Cement is one of the most important barrier materials in the well. The aim of this project is to experimentally study degradation mechanisms and sealing ability of cement sheaths and cement plugs. Such an improved understanding of cement integrity will lead to fewer well integrity problems both during production and after abandonment.

A unique laboratory set-up is used to study degradation of annulus cement sheaths during pressure cycling, where formation of radial cracks and microannuli in the cement sheath are quantified and digitally visualized in 3D by X-ray Computed Tomography (CT). During 2018, it has been verified experimentally that rock stiffness has a major impact on cement integrity. It is also observed that the radial cracks in the cement continue into the rock as well.

Furthermore, the integrity of cement plugs is studied in a dedicated experimental set-up, where gas flow around the plugs is measured at different pressure differences. During 2018, it has been found that the surface roughness of the casing can have a significant impact on the sealing ability of cement plugs.



Effect of casing surface roughness on cement plug integrity (Corina et al., SPE/IADC-194158-MS)



CT visualization of radial cracks formed in cement sheath and rock during pressure cycling (Vrålstad et al., SPE/IADC-194171-MS)

Hans Joakim Skadsem, project manager of Cementing Irregular Wellbore Geometries.

PROGRAMME 3

Cementing irregular wellbore geometries

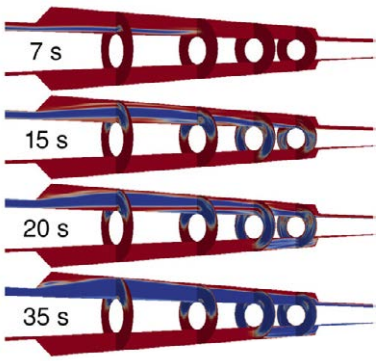
The primary cementing of casing is among the most critical operations during well construction and one that affects the entire life cycle of a well. The objective of this project is to improve knowledge of fluid displacement and cementing in wellbores with irregular annulus geometry through experiments and numerical simulations.

Numerical simulation of annulus displacements is an important step for planning and predicting primary cementing of casings. As a step toward strengthening our understanding and predictive capability of displacement flows in irregular geometries, results from our displacement experiments have been compared to simulation results obtained with our 3D open-source numerical model. The position of the fluid-fluid interface was predicted numerically and compared with experimental results.

The experiments and our 3D simulations agree well in many cases, with simulations replicating qualitative trends and matching several fluid interface arrival times from the experiments. Casing eccentricity promotes flow on the wide (upper) side of the annulus and the simulations show in detail how eccentricity affects displacement inside the hole enlargement; particularly for the horizontal annulus, eccentricity results in poor displacement of our model washout. When comparing results from a 2D gap-averaged model and our full 3D model, we find similar displacement trends in the regular part of the annulus but qualitative differences inside the washout. While 2D displacement models allow simulating displacements over the entire length of the wellbore, a full 3D simulation is necessary for retaining details in the radial direction; this is important for predicting residual layers of mud close to the walls and flow in regions of the wellbore where the geometry varies significantly.

a)

b)



a) Displacement results were obtained using a 10 m long flow loop with distributed conductivity probes for detecting the fluid interface position during displacement. b) Numerical simulations using a 3D open-source platform have been performed to analyse the experiments.

Technologies for barrier evaluation and P&A

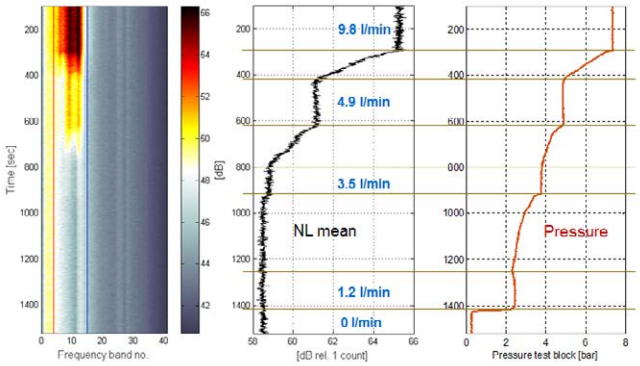
During slot recovery and permanent plug and abandonment (PP&A) operations well barriers must be verified. For well PP&A, considerable savings can be realized if the production tubing can be left in hole, however casing annular isolation must first be verified through tubing. The verification of well barriers behind multiple casings is an industry challenge. The goal of this project is to investigate the performance of verification technologies with a particular focus on barrier evaluation behind multiple casings.

Casing barrier reference cells have been constructed that represent a range of annular leakage scenarios (e.g. gas channels, mud channels and micro-annuli). These cells are being used to evaluate the performance of commercially available logging services and new technology concepts. The cell leakage properties have been physically measured by leakage tests using water and gas.

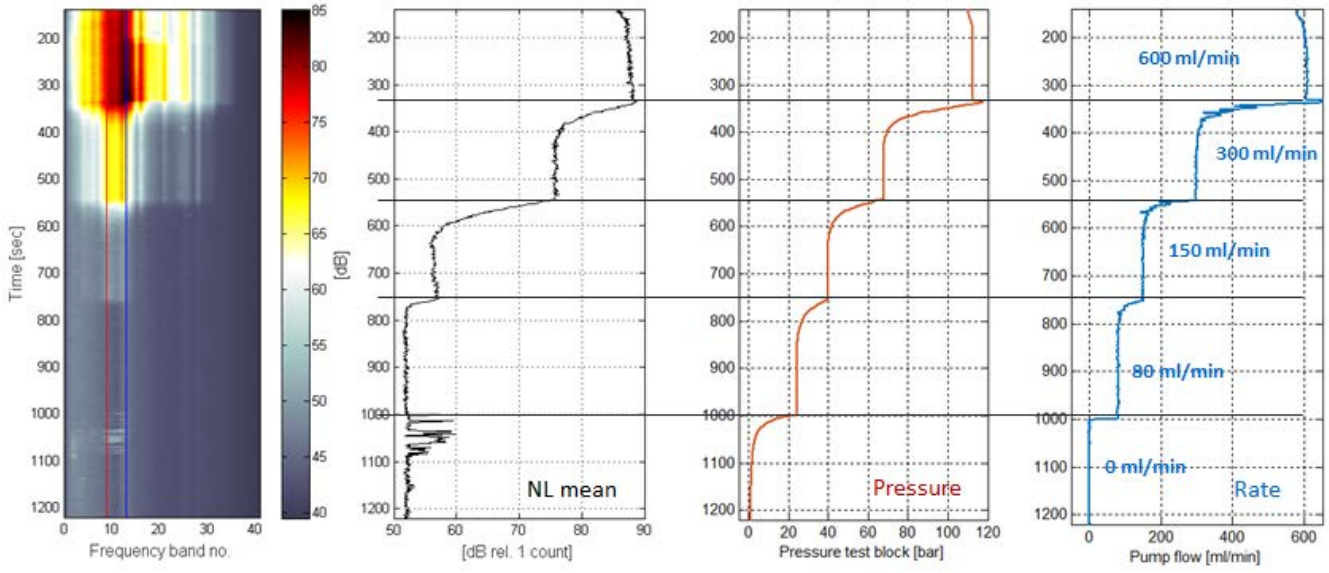
Reference cells have also been built to represent abandonment plugs with different leakage properties. The purpose of these cells is to evaluate emerging verification techniques such as utilizing pressure testing methods and tracer gases. The cells can also be used to investigate the properties of fluid migration paths and support the development of improved leakage flow models.

In 2018 an experiment has been executed to investigate the measurement resolution of Archer's VIVID™ acoustic listening platform logging tool. The tool was run in various barrier reference cells and the acoustic response recorded for varying flowrates of water and gas. The reference cells were rigged up in a sound proof environment which ensured only flow generated noises were present during surveys.

The recorded data showed that the acoustic listening technology was able to detect flow generated noise at low water and gas flowrates. The figures show the VIVID™ logging tool response to different water and gas flowrates in the micro-annulus barrier reference cell. The noise recorded (NL mean) correlates well to the flowrate steps.



VIVID™ logging tool response versus gas flowrate in the micro-annulus barrier reference cell. (Figure courtesy of Archer.)



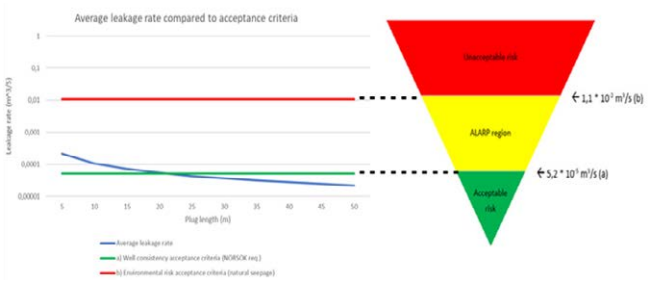
VIVID™ logging tool response versus water flowrate in the micro-annulus barrier reference cell. (Figure courtesy of Archer.)

PROGRAMME 3

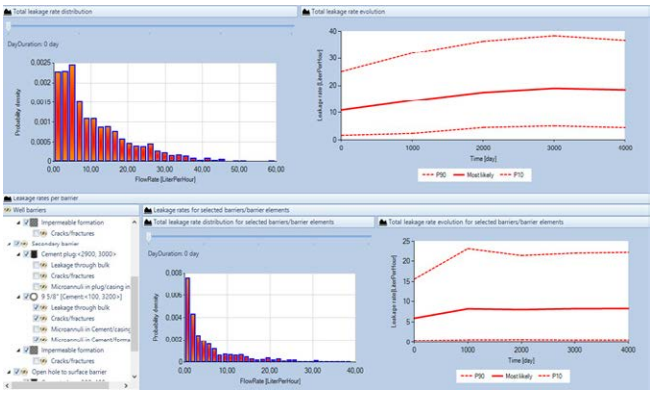
Leakage risk assessment for plugged and abandoned oil & gas wells

P&A well design performed on the NCS today follows a best practice approach. This means that the selected P&A solution either adheres to NORSOK D-010, or even stricter company standards set by the different operators. There is however a need for a methodology that can quantify the quality of a given P&A solution, in order to help reduce potentially high costs. The development of a methodology for assessing the probability and consequences (in terms of leakage rate), is the objective of this project.

During the past year, the project has focused both on modelling aspects and software development. A model for estimating far-field stress changes in the overburden post-abandonment has been established. The estimates from this model enables the computation of the stress at the cement/formation, which in turn can predict whether post-abandonment stress changes can compromise zonal isolation. Coupling such a model to a framework which includes failure criteria and lifetime considerations, can be used to infer failure probability of the cement in terms of mean time to failure. A model is also being developed to address acceptance criteria for permanently P&A'ed wells, using the ALARP principle, and considering various decision criteria. The software prototype has been issued to the DrillWell partners for early testing and feedback and is currently fully running with a user-friendly GUI for all currently developed models.



Concept of leakage rate acceptance criteria with defined regions for unacceptable and acceptable risk. This provides a better reference point for evaluating simulated leakage rates.



Current graphical user interface of main leakage rate results, where both total leakage rate and leakage rate for selected well barrier elements is provided. The leakage rates can also be shown as a function of time.

DrillWell

DRILLING AND WELL CENTRE
FOR IMPROVED RECOVERY

PhD students

MARIUS STAAHL NILSEN

Department: Department of Geoscience and Petroleum, NTNU

Main topic of PhD Thesis: Dynamic behavior of formation gas in oil-based mud

Main contribution to the research field: My research aims to describe the dynamic behaviour when gas is liberated from a saturated mud during pressure depletion. As large quantities of formation gas can be dissolved into an oil-based mud during a gas kick, it is important to understand when, and at what rate, free gas will appear in the wellbore.

ANISA NOOR CORINA

Department: Department of Geoscience and Petroleum, NTNU

Main topic of PhD Thesis: Cement plug integrity within plug & abandonment phase

Main contribution to the research field: The objective of this project is to study the sealing ability of cement plugs throughout the life-cycle of the well, especially during the well P&A phase. The tasks will focus on determining the sealing ability of cement plugs at different conditions, such as the effect of additives (with an emphasis on expandable cement), presence of mud, plug length, etc.

JACOPO PAGLIA

Department: Department of mathematical sciences, NTNU

Main topic of PhD Thesis: Statistical models for pore pressure prediction and drilling window.

Main contribution to the research field: Build statistical models for pore pressure over a spatial domain and link this variable to measurements made in wells. The key goal is to predict the pore pressure (with uncertainties) at various depths, ahead of the drill-bit, before the well is drilled to that depth. Pore pressure prediction will be connected with the mud-weight window characteristics.

SOLVEIG RIISØEN

Department: NORCE Energy – Drilling and Well Modelling

Main topic of PhD Thesis: A study on the accuracy of the modelled frictional pressure loss based on rheological characterization of the drilling fluid.

Main contribution to the research field: The overall objective of this project is to investigate the accuracy of the modelled frictional pressure loss of a typical drilling fluid, using a rheology curve produced by a Couette type rheometer and later look at the effect of solids particles on the predictability of frictional pressure loss.

SHREYANSH DIVYANKAR

Department: Petroleum Engineering, University of Stavanger

Main topic of PhD Thesis: Cementing irregular wellbore geometries

Main contribution to the research field: The research work aims to study velocity profiles in irregular wellbore geometries (washouts and eccentricity) and gain a better understanding of displacement efficiency during primary cementing.

DALILA DE SOUSA GOMES

Department: Petroleum Engineering, University of Stavanger

Main topic of PhD Thesis: Improved dynamic modelling of two phase flow in well control operations.

Main contribution to the research field: The thesis work is about how we can improve transient flow models for better prediction of well control scenarios with focus on oil-based muds. The plan is to also integrate new PVT sub-models under development in DrillWell. Improved models can be used for increased knowledge about safety critical issues, training as well as providing input to procedures. Improved models can be used for developing tools that can be used in an operational environment.

DrillWell Post Docs

Name: Geir-Ove Strand

Department: Geoscience and Petroleum, NTNU

Main topic of post doc work: Technologies for barrier evaluation and P&A with special focus on 'technologies for shale barrier evaluation in the North Sea'.

The objective of plugging and abandonment (P&A) is for a well to be isolated 'forever'. The long-term sealing requirement is a critical factor in a highly regulated North Sea environment, and the industry two-barrier rule suggests that plug isolation needs to be verified by testing or equivalent method independent of material used for P&A. The acceptance criteria and the means for verification of plugs will as such be critical to identify the optimal P&A solution. It has been suggested that cement evaluation tools can be used to help verify the presence of a shale formation that has formed a barrier outside the casing.

The ability of these tools to help determine an acceptable well leakage risk level, however, remains a subject of dispute in the industry. In this DrillWell sub-project we aim to present results that may help contribute to resolving this dispute. The sub-project objective is to design and build a full-scale 'shale as barrier' reference calibration cell. The reference cell is to be designed and made accessible to existing and emerging annulus barrier evaluation methods. The purpose is to help increase the quality of decisions made from such barrier evaluation technologies in an explicit well P&A safety context.

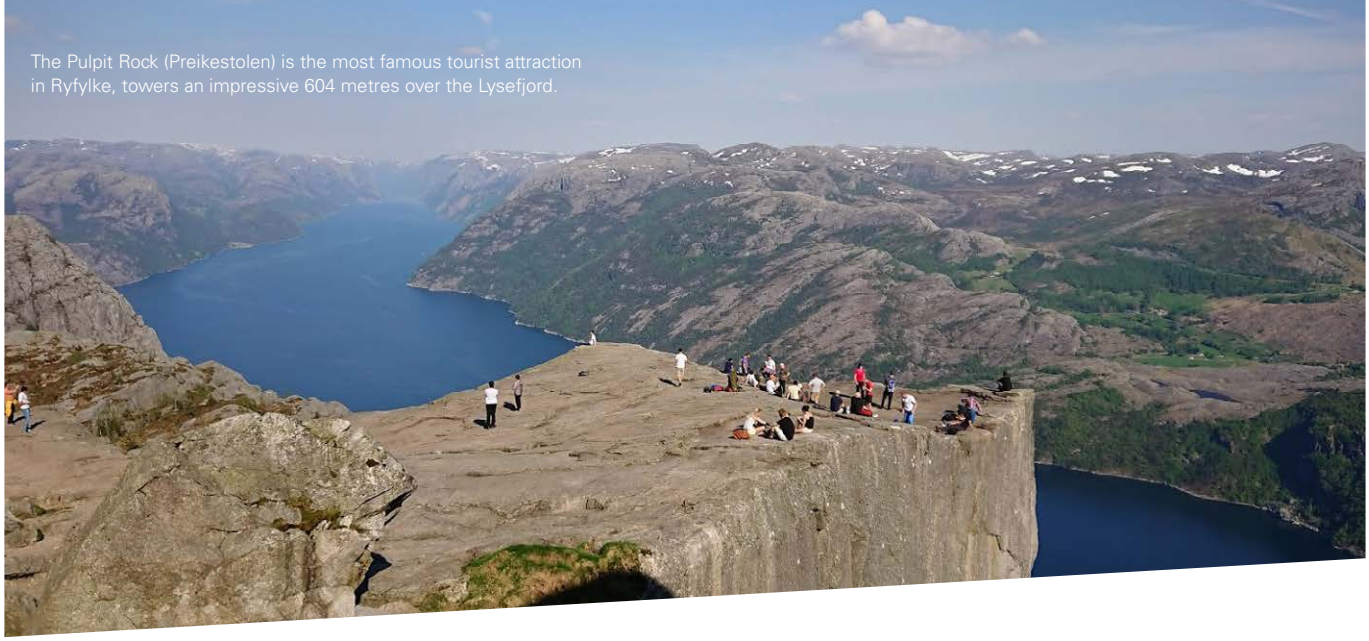
Name: Sohrab Gheibi

Department: Geoscience and Petroleum, NTNU

Main topic of post doc work: Numerical modelling of cement sheath integrity

Cement sheaths are considered to be one of the most important well barrier elements in the well, during production and well abandonment. However, the cyclic temperature and pressure variations caused during normal production operations, such as shut-down/start-up, stimulations degrade the integrity of the cement sheath. As a result, the casing undergoes expansion and contraction inducing stresses in the cement sheath. Above a certain limit, this can lead to formation of fractures and microannuli in the cement sheath and consequently failure to act as a well barrier element.

Previous experimental studies performed in the DrillWell showed that the casing pressure test can lead to formation of radial fracture in the cement sheath and the fracture can propagate into the rock formation. I am using a hybrid FEM/DEM numerical code to simulate such experiments to understand how the result could be finally extended to a more realistic field-scale condition.



The Pulpit Rock (Preikestolen) is the most famous tourist attraction in Ryfylke, towers an impressive 604 metres over the Lysefjord.

International collaboration

NORTEX OTC 2018 DIGITALIZATION WORKSHOP

DrillWell had a pivotal role in international collaboration at the OTC in Houston, Texas in 2018. Working alongside partners from the University of Austin Texas, Rice University, The University of Agder and the Global Center of Expertise (GCE) NODE, the group, which met under the banner of the NorTex Data Science Cluster, hosted a day-long seminar focused on digitalization and interoperability.

Held on May 2nd, the three-session workshop focused first on Emerging Digital Technologies, before moving on to Advanced Monitoring and Analytics, and finally Connectivity. Now in its fourth year, the workshop has year by year strengthened the international collaboration between the global partners in Norway and Texas.

"The point of the project is to create a cluster," says Fionn Iversen, NORCE Energy Chief Scientist, who leads the project from the DrillWell perspective. "We are together working towards a sustainable cluster for data science with focus on research and academia." With funding from the Research Council of Norway's INPART (International Partnership for Excellent Education Research) programme, Iversen is hopeful that the fruitful collaboration to date, will translate into more funding in the future. "Together we are doing very valuable work," he says.

ONS STAVANGER

DrillWell also collaborated with the NorTex Data Science Cluster during the ONS Conference in Stavanger in August 2018. The same team gathered again for another valuable workshop with an international flavour.

Held on August 30, the ONS workshop was split into two parts, focusing on Data Integration Through OPC UA: Industrialisation, Opportunities and Challenges followed by Data Science Challenges and Opportunities for Collaboration.

COLLABORATION ON RESEARCH PAPERS

The pan national collaboration transcends the regular scheduled workshops, with academics leveraging the flourishing international network to work across borders on important research.

Papers have already been published under the Data Science Cluster workstream, and lab work for several papers is underway, with a close co-operation between academics also creating avenues into industry. Collaboration between academics at DrillWell, The University of Texas Austin, and Apache is already yielding impressive results.

"We are working together on data semantics which is important for automated drilling applications," says Iversen. "We are doing this work in relation to the DrillWell Drilling Data Hub, and moving forward with project development," he says.

EPIC FOURTH COLLOQUIUM

Ulf Jakob Aarsnes is a researcher at NORCE and together with Nathan van de Wouw, Emmanuel Detournay and Vincent Denoël he was responsible for organizing the Fourth International Colloquium on Nonlinear Dynamics and Control of Deep Drilling Systems which was held from May 14th -16th at Preikestolen fjellstue in Norway.

Presentations in the Preikestolen fjellstue.

Jan Einar Gravdal, NORCE, was one of the researchers joining OTC on behalf of DrillWell.

Communication and dissemination activities

DrillWell is committed to sharing knowledge and experience and communicating its work to the industry and academia. During 2018, the organization was visible in high profile conferences and seminars throughout the world showcasing its cutting edge technology and research, and making strides in automated drilling and well efficiency.

THE FOREMOST ANNUAL DRILLING CONFERENCE

The SPE/IADC Drilling Conference was held in Fort Worth from March 6-8. DrillWell was highly visible at the event, sharing knowledge on several topics critical to the future of the oil and gas industry with the presentation of five papers. Boundary conditions, reconstruction of pipe displacement, molecular diffusion of methane in wells, and digitalized uncertainty, were all in the spotlight, alongside results from a DrillWell well control simulator.

THEORETICAL AND APPLIED RESEARCH

On April 18 the SPE Norway One day seminar was arranged in Bergen. With five papers, DrillWell was again leading the way in bringing critical laboratory and industrial research into the oil and gas industry. Enhancing well control and analysing asymmetric tool-joint wear created the opportunity for improvements in drilling for the whole industry, while laboratory theories were in the limelight with presentations on transient models for kick management, transforming the concentric annulus for lab measurements, and creating an experimental facility for evaluating well barrier verification technology.

At the SPE/IADC Drilling Conference: Jan David Ytrehus, Jan Ove Skogestad and Ane Lothe, SINTEF and Adrian Ambrus and Eric Cayeux, NORCE.

DrillWell researchers at the OMAE conference, Madrid.

SUPPORTING SCIENTIFIC ADVANCES

DrillWell joined researchers, engineers, managers, technicians and students from the scientific and industrial communities from around the world in Madrid on June 17-22. At the ASME 37th International Conference on Ocean, Offshore & Artic Engineering, OMAE2018, DrillWell moved the dial for advances in technology and scientific support. Among the many hundreds of papers presented at the event, DrillWell shared its own expertise with seven of its own, including new technologies for shale barrier evaluation in the North Sea and a laboratory test on cement plug integrity.

P&A SPECIALITY

The SPE Annual Technical Conference and Exhibition ATCE2018 on September 24-26 is the yearly opportunity for members to meet up, and the event features groundbreaking papers and special technical events designed to accelerate the application of innovations in every technical discipline. For DrillWell, it was an opportunity to showcase its knowledge in plugging and abandonment, asking the question: Permanent P&A Design – What is Good Enough?

INTERNATIONAL NETWORKING AND COLLABORATION

The Offshore Technology Conference (OTC) 2018 was held in Houston, Texas from April 30 to May 3. The conference represented an opportunity for DrillWell to meet and work together with its international network. Key amongst the activities at the event was a full-day digitalization workshop. Held at Rice University, with a focus on digitalization and interoperability, the conference helped to expand the international collaboration and, with other activities, set the groundwork for distributing cutting edge thinking in training and education internationally.

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Tasty new mathematics to solve old problems in drilling

Ulf Jakob Aarsnes is tackling one of the knottiest problems in long well drilling. Pursuing an academic career using mathematical formulae developed alongside DrillWell, the post doc researcher is helping controllers at the top of the well understand exactly what is happening at the bottom.

Infinite dimension systems are not the hottest topic of conversation at a standard dinner party. But during his travels to San Diego, via Trondheim and Oslo, post doctorate researcher, Ulf Jakob Aarsnes has made it his business to get to know them intimately. When he travels next year to the gastronomic capital of the world in Paris, he will be able to cook up theoretical solutions to some of the most tricky and potentially costly problems in drilling. And he hopes to boil those solutions down to a point where they can be used simply in automated drilling control.

"When we are drilling a well we are making a very long annulus or conduit where mud and potentially gas moves through. It could be up to 10km. At the same time it is very slim," he says. "Most of the stuff you are measuring and changing is at the top of the well. But most of the interesting stuff is actually at the bottom."

The normal way of understanding what happens in between is to apply low dimensional systems. This is a robust mathematical model in most circumstances but in long reach wells with many more variables, the transportation effects mean this approach can be inadequate, says Dr Aarsnes.

"If you turn a drillstring 180 degrees at the top of a well, it is unlikely that the bit will turn 180 degrees at the bottom, because there is a lot of other stuff happening in between. So to be able to connect this, you need a mathematical model, describing everything that happens throughout the well. To describe this system mathematically, you need infinite dimensional systems. You cannot describe it effectively with a low dimensional system."

THEORY INTO PRACTICE

A prolific author, Aarsnes has published more than 30 papers applying his mathematical brain to subsurface problems. After completing his PhD in NTNU, he travelled to Oslo to work as a post doc alongside DrillWell and managed to attain a stipend from the Research Council of Norway aimed at young researchers who want to strengthen their international networks, to explore his subject in California.
"I wanted to solve problems related to robust control of infinite dimensional systems," he says. The people doing the most advanced work in the subject are at The University of California San Diego, where Dr Aarsnes is now in the second of a two-year stint. "What has happened in the last 15 years is that there are certain new tools developed by this group in San Diego that allow researchers to solve a whole new class of problems. They have done a lot of very interesting work.

"But even though there have been a lot of papers on this it hasn't been a lot of test cases yet. So what I wanted to do is go in and try to bridge some of the gaps from the theory to the practice and make them applicable to industrial problems."

COMING BACK TO EUROPE

Next year he will move to Paris to finish his research at the Mines ParisTech before coming back to Oslo in 2020. "I hope to continue to be a senior researcher with DrillWell when I return, using my research to solve problems in oil and gas." But his work has also given him ideas for how he might use his skills and knowledge for the benefit of other industries. "For example, I am looking at other dynamical behaviour that is described by infinite dimensional systems. One of the things I am looking at is the stability of large interconnected power grids," he says.

So while it may not be dinner party conversation in most households, Dr Aarsnes's research and academic career will likely provide food for thought for many more people in the future.

Bringing her research into the industrial world

Fatemeh Moeinikia is working with one of the fastest growing operators on the Norwegian Continental Shelf. Using the work she did as a PhD/post-doctorate with DrillWell, the engineer is applying her P&A skills to slot recovery for Aker BP.

As the Norwegian Continental Shelf matures, and greenfield drilling is replaced by brownfield work, the role of P&A will become ever more important. Thousands of wells on the shelf will need to be plugged and abandoned in the coming decades and making that as safe and cost effective as possible is an ongoing concern.

"My thesis was looking at cost effective technologies for plugging and abandonment, time and cost estimation for P&A and other aspects such as how we can include P&A in well design. After that at post doc, it was leakage risk assessment for P&A in oil and gas wells," she says.

P&A well design performed on the NCS today follows a best practice approach. But this approach does nothing to measure the quality of the solution, making the introduction of alternative designs challenging. In her research, Moeinikia set out to overcome that challenge.

IN THE INDUSTRY

"Yes I am using my skills. Absolutely it helps. It is different, but of course, my research helps a lot to better understand operations. But it is clear there are a lot of things to learn in an operational setting. I think it is very important and necessary to have operational experience. It shows what is happening in real life, and you get a better understanding of research as well," she says.

Today she is working operationally with talented colleagues in slot recovery team on Ula field, plugging and abandoning existing wells in preparation for drilling new wells from the same slots. Through this, she is finding professional satisfaction by contributing to extending the lifetime of a mature field.

However, she does not reject the idea of moving back into academia.

RESEARCH FOCUS

"Of course I would like to write research papers again. It would be possible to write a research paper while working in the industry. There are a lot of papers written within industry. In that sense I would I guess be looking at the operation and a real case. I can see myself writing a research paper in these circumstances," she says.

Before heading back to academia full time, if ever she decides, she is clear that there is much more she wants to learn from an operational perspective.

"Even if I want to go back in the future, for sure I would like to get several years of working in industry. I am very happy here and I hope there is a chance for me to stay and become involved in other projects in the future."

The annual DrillWell seminar

DrillWell's annual two-day seminar at the Sola Strand Hotel in September brought together industry and academia to chew over the most important topics affecting the drilling space. Improvements through innovation and collaboration, and research on drilling, cementing and P&A led the programme, which was hungrily consumed by more than 100 delegates at the event.

Co-moderated by NORCE's new Director of Energy, Aina Berg, and Research Director Helga Gjeraldstveit, the first day of the conference shone a torch on using drilling technology to manage the total cost of the well.

DrillWell Manager Sigmund Stokka opened the event, with a speech outlining the importance of collaboration between industry and research institutions and academia. His theme was picked up in the keynote address by Equinor's Leader Drilling and Well Technology, Dag Økland who urged the audience to abandon "conservatism" and be prepared to be innovative.

With a plea to focus more strongly on sustainability on the NCS through gas production and CO2 reduction, he said drillers needed to drill smarter smart wells. "We often have two reasons for not trying something new," he said "1) We tried that before or 2) We never tried that before. Meaning oil and gas is a very conservative business and a conservative mindset is an obstacle for innovation." He said the innovative work, for example, done with DrillWell to implement DrillTronics technology on the rig Songa Enabler had led to fewer sidetracks and significant cost reduction.

Other industry collaborations were also hot topics at the event with Eric Cayeux from NORCE and Leif Stokland from Wintershall presenting *Tool Joint Wear. The story of the Wintershall operated Maria field and its problems with worn tool joints causing added time and costs.* Wintershall contacted DrillWell to sort it out and Eric Cayeux presented what was the probable cause of the problem and a solution to mitigate.

NORCE's Benoit Daireaux's presentation of *The Drilling Data Hub (DDHub)*, a prototype for a new data hub that acquires and processes real-time data from drilling operations was another highlight, with more presentations from Equinor, NOV, NTNU and Odfjell Drilling attracting enthusiastic attention.

Delegates from Petrobras: Fabio Rebelo, Marcelo Minto, Fafael Camel and Fabio Omara.

Sigbjørn Sangesland, NTNU and Axel-Pierre Bois, CEO Curistec to right.

The annual seminar was held at Sola Strand Hotel.

DrillWell board member Harald Linga from SINTEF welcomed the delegates on day two and moderated the rest of the seminar that had a special focus on Cementing and P&A.

Linga introduced the first speaker, Ragnhild Skorpa from SINTEF who presented *Cement sheath integrity during pressure cycling*, before Morten Ivar Andersen from Archer and Dave Gardner from NORCE talked about *Cement performance evaluation testing with a new broad spectrum acoustic tool*.

The supply chain was well represented, with presentations from Halliburton, Curistec and Schlumberger all attracting attention. First Halliburton's Gunnar Lende presented *Annular cement integrity test cell*, which is a joint test project with Equinor, before Philippe Tardy from Schlumberger presented *Modelling annular displacements of wellbore completion fluids*, concluding that novel models allow solving 3D flows at a lower cost than 3D simulations. The *Cement Integrity Modelling* presentation from Axel-Pierre Bois, CEO of Curistec, fitted neatly into the theme of the day.

Later, it was the turn of the academics, with PhD student at NTNU, Anisa Noor Corina presenting *Effect of casing surface roughness on cement plug sealing ability* and Øystein Arild from NORCE talking about *P&A leakage risk assessment*.

NORCE's Hans Joakim Skadsem presenting *Full-scale cementing experiments in an irregular annulus geometry*, and Post doc, Mahmoud Khalifeh from UiS wrapped up the day. Khalifeh's *SafeRock as an alternative to cement for zonal isolation and P&A – opportunities and barriers*, was a fitting piece of cutting-edge science with which to end the session. SafeRock is a new material that is an alternative to cement.

"I think it has been a very successful seminar with good presentations and proof of great interaction between researchers and the industry", concluded DrillWell Director Sigmund Stokka.

DRILLWELL RESEARCHERS

Helga Gjeraldstveit	NORCE	Drilling and well technology
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Sergey Alyaev	NORCE	Computer modelling
Steinar Kragset	NORCE	Computer modelling
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Benoit Daireaux	NORCE	Drilling and well modelling
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Mahmoud Khalifeh	UiS	Plug and abandonment
Helge Hodne	UiS	Fluid mechanics
Rune W. Time	UiS	Fluid physics
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Jan Ole Skogestad	SINTEF	Drilling and well modelling
Johnny Frøyen	SINTEF	Drilling and well modelling
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Harald Linga	SINTEF	Drilling and well technology
Ali Taghipour	SINTEF	Drilling and well technology
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Pål Skalle	NTNU	Drilling engineering
Sigve Hovda	NTNU	Drilling engineering

DRILLWELL PUBLICATIONS

JOURNAL

Aarsnes, U.J.F., Acikmese, B., Ambrus, A. and Aamo, O.M. 2016. ''Robust Controller Design for Automated Kick Handling in Managed Pressure Drilling''. Journal of Process Control, vol 47, November, pp 46-57.

Aarsnes, U.J.F., Ambrus, A., Di Meglio, F., Vajargah, A.K., Aamo, O.M., van Oort, E. 2016. ''A Simplified Two-Phase Flow Model using a Quasi-Equilibrium Momentum Balance''. International Journal of Multiphase Flow, vol. 83, pp 77-85.

Aarsnes, U.J.F., Flåtten, T., Aamo, O.M. 2016. ''Review of two-phase flow models for control and estimation''. Annual Reviews in Control, vol 42, 2016, p 50-62.

Aarsnes, U.J.F., Van de Wouw, N. 2017. ''Dynamics of a distributed drill string: Characteristic parameters and stability maps''. Journal of Sound and Vibration.

Aarsnes, U.J.F., Shor, R. 2017. ''Torsional vibrations with bit off bottom: modeling, identification and field data validation''. Journal of Petroleum Science and Engineering.

Aas, B., Sørbø, J., Stokka, S., Saasen A., Godøy, R., Lunde, Ø. and Vrålstad, T. 2017. ''Cement Placement with Tubing Left in Hole during Plug and Abandonment''. JPT Journal.

Abrahamsen, E.B., Selvik, J.T. 2014. ''A framework for selection of inspection intervals for well barriers''. ESREL conference London, 29 Sep-2. Oct.

Ambrus, A., Ambrus, A., Aarsnes, U.J., Vajargah, A.K., Akbari, B., van Oort, E., Aamo, O.M. 2016. ''Real-Time Estimation of Reservoir influx Rate and Pore Pressure Using a Simplified Two-Phase Flow Model''. Published online in Journal of Natural Gas Science and Engineering.

Amirhossein, N., Aarsnes, U.J.F. and Johansen, T.A. and Kaasa, G.-O. 2017. ''State and Parameter Estimation of a Drift-Flux Model for Under-Balanced Drilling Operations''. IEEE transactions on control systems technology.

Askarinezhad, R., Hatzignatiou, D.G., Stavland, A. 2017. ''Disproportionated Permeability Reduction of Water-soluble Silicate Gelants - Importance of Formation Wettability''. SPE Production & Operations (ISSN 1930-1855).

Assembayev, D., Myrseth, V., Werner, B., Gyland, K.R., Saasen, A., Ibragimova, Z., Ytrehus, J.D. 2016. ''Establishing an experimental pre-conditioning procedure for rheological characterization of oil based drilling fluids''. Annual Transactions of the Nordic Rheology Society, Vol. 23, 2015.

Cayeux, E., Daireaux, B. 2016. ''Insights in the Physical Phenomena that Influences Automatic Gain/Loss Detection during Drilling Operations''. SPE Drilling & Completion, SPE-166801-PA.

Cayeux, E., Taiwo, M., Tanripada, S., Zidan, M., Fjelde, K.K. 2014. ''Real-time Evaluation of Hole Cleaning Conditions Using a Transient Cuttings Transport Model''. SPE Drilling and Completion Journal, Vol 29, No.1.

Cayeux, E., Daireaux, D., Balov, M.K., Haavardstein, S., Stokland, L.M., Saasen, A. 2017. ''Embedding Automatic Risk-Level Estimation and Performance Analysis in Drilling Plans''. JPT Journal, Volume 69, Issue: 9, 1. September.

Cayeux, E., Shor R., Ambrus, A., Pournazaric, P., Ashokc, P., van Oort, E. 2017. ''From Shallow Horizontal Drilling to ERD Wells: How Scale affects Drillability and the Management of Drilling Incidents''. Journal of Petroleum Science and Technology, Vol 160, pp 91-105, January.

Chen, Y., Lorentzen, R.J., Vefring, E. 2014. ''Optimization of Well Trajectory Under Uncertainty for Proactive Geosteering''. SPE-172497-PA. SPE Journal.

De Andrade, J., Sangesland, S. 2016. ''Cement Sheath Failure Mechanisms: Numerical Estimates to Design for Long-Term Well Integrity''. Journal of Petroleum Science and Engineering (ISSN 0920-4105), vol 147, pp 682-698.

De Andrade, J., Sangesland, S., Todorovic, J., Vrålstad, T. 2016. ''Cement Sheath Integrity During Thermal Cycling: A Novel Approach for Experimental Tests of Cement Systems''. SPE-173871-MS, Journal of Petroleum Science and Engineering.

De Andrade, J., Sangesland, S., Skorpa, R., Todorovic, S., Vrålstad, T. 2016. ''Experimental Laboratory Setup for Visualization and Quantification of Cement-Sheath Integrity''. SPE Drilling & Completions, SPE.173871-PA.

Gardner, D., 2017. ''Reducing the cost of Well abandonment''. Oil and Gas European Magazine, Vol 1, January.

Gelyani, A.M., Selvik, J.T., Abrahamsen, E.B. 2014. ''Decision criteria for updating test intervals for well barriers''. Journal of Risk Research.

Gravdal, J.E., Hardy, S., Bjørkevoll, K.S. 2018. ''Limiting Factors for the Ability to Achieve Accurate Pressure Control in Long Wells''. Modeling, Identification and Control Journal, Vol 39, No 2, pp 115-129.

Hatzignatiou, D.G., Askarinezhad, R., Giske, N.H., Stavland, A. 2016. ''Laboratory Testing of Environmentally Friendly Sodium Silicate Systems for Water Management Through Conformance Control''. SPE Productions & Operations, vol 31, Issue 04, pp 337-350, November.

Hatzignatiou, D.G., Askarinezhad, R., Giske, N.H., Stavland, A. 2016. ''Laboratory Testing of Environmentally Friendly Sodium Silicate Systems for Water Management''. SPE-173853PA, SPE Production & Operations Journal.

Johansen, T.A., Sui, D., Nybø, R. 2013. ''Regularized Nonlinear Moving horizon Observer with Robustness to Delayed and Lost Data''. IEEE transactions on control systems technology.

Khalifeh, M., Gardner, D., Haddad, M.Y. 2018. ''Technology Trends in Cement Job Evaluation Using Logging Tools''. Journal of Petroleum Technology, vol 70, no 5, pp 74-77.

Khalifeh, M., Saasen, A., Vrålstad, T., Hodne, H. 2014. ''Potential Utilization of Class C Flash-based Geopolymer in oil Well Cementing Operations''. Journal of Cement and Concrete Composites 53, p 10-17, Elsevier.

Khalifeh, M., Saasen, A., Vrålstad, T., Larsen, H.B. Hodne, H. 2015. ''Experimental study on the synthesis and characterization of aplite rock-based geopolymers''. Journal of Sustainable Cement-Based Materials.

Khalifeh, M., Todorovic, J., Vrålstad, T., Saasen, A., Hodne, H. 2016. ''Long-

term durability of rock-based geopolymers aged at downhole conditions for oil well cementing operations". Journal of Sustainable Cement-Based Materials.

Khalifeh, M., Saasen, A., Larsen, H.B., Hodne, H. 2017. "Development and Charcterization of Norite-Based Cementitious Binder from an Ilmenite Mine Waste Stream". Hindawi, Advances in Materials Science and Engineering, vol. 2017, Article ID 6849139, 7 pages.

Kullawan, K., Bratvold, R., Bickel, J.E. 2014. "A Decision Analytic Approach to Geosteering Operations". SPE Drilling & Completions Journal, vol. 29, No.1.

Kullawan, K., Bratvold, R., Bickel, J.E. 2016. "Value creation with multi-criteria decision making in geosteering operations". International Journal of Petroleum Technology Vol. 3, No 1, pp 15–31.

Kullawan, K., Bratvold, R., Nieto, C.M. 2016. "Decision-Oriented Geosteering and the Value of Look-Ahead Information: A Case-Based Study". Paper SPE 184392. SPE Journal, October.

Kullawan, K., Bratvold, R., Nieto, C.M. 2016. "Decision-oriented geosteering and the value of look-ahead information: A case-based study". SPE Journal.

Lamare, P.O., Auriol, J., Di Meglio, F., Aarsnes, U.J.F. 2018. "Statistical modeling for online pore pressure prediction from pre-drill analysis and well logs". Submitted to the American Control Conference (ACC) 2018.

Lavrov, A., Larsen, I., Bauer, A. 2015. "Numerical modeling of extended leak-off test with a pre-existing fracture". Journal of Rock Mechanics and Geotechnical Engineering. ISSN 0723-2632. Paper version April 2016, vol 49, no 4, p1359-1368.

Linga, H., Bjørkevoll, K. S., Skogestad, J.O., Saasen, A. 2017. "Study targets potential for gas loading in drilling fluids to improve influx detection, management". Drilling Contractor July/Aug, Vvl 73, no 4, pp 44-49.

Liu, Y., Draganov, D., Wapenaar, K., Arntsen, B. 2016. "Retrieving virtual reflection responses at drill-bit positions using seismic interferometry with drill-bit noise". Geophysical Prospecting, Vol. 63.

Liu, Y., Draganov, D., Wapenaar, K., Arntsen, B. 2016. "Retrieving virtual reflection responses at drill-bit positions using seismic interferometry with drill-bit noise". Geophysical Prospecting, vol 64, no 2, pp 348-360.

Liu, Y., van der Neut, J., Arntsen, B., and Wapenaar, K. 2016. "Data-driven deep local imaging near horizontal wells using both surface and borehole data". Geophysical Journal International, vol 205, no 2, pp 758-775.

Liu, Y., van der Neut, J., Arntsen, B., Wapenaar, K. 2016. "Combination of surface and borhole seismic data for robust deep target-oriented imaging without accurate velocities". Geophysical Journal International, vol. 205, no 2, p 758-775.

Moeinikia, F., Ford, E., Lohne, H.P., Arild, Ø., Fjelde, K.K. 2018. "Leakage Calculator for Plugged-and-Abandoned Wells". SPE Productions and Operations.

Moeinikia, F., Fjelde, K.K., Saasen, A., Vrålstad, T. 2015. "Probabilistic Cost and Time Estimation of Rigless Plug and Abandonment". JPT Journal.

Moeinikia, F., Fjelde, K.K., Saasen, A., Vrålstad, T., Arild, Ø. 2015. "A Probabilistic methodology to Evaluate the Cost Efficiency of Rigless Technology for Subsea Multiwell Abandonment". SPE Production and Operations.

Paglio, J., Eidsvik, J., Grøver, A., Lothe. A.E. 2018. "Statistical modeling for online pore pressure prediction from pre-drill analysis and well logs". Journal of Geophysics.

Pedersen, T., Aarsnes, U.J.F., Godhavn, J.M. 2018. «Flow and pressure control of underbalanced drilling operations using NMPC". Journal of Process Control, vol 68, August 20, pp 73-85.

Romdhane, A., Querendez, E. Helset, H.M. 2012. "FWI for Sub-surface Imaging in the Context of Seismic while Drilling-Synthetic Study". EAGE Conference & Exhibition.

Skadsem, H.J., Leulseged, A. 2018. «Measurement of Drilling Fluid Rheology and Thixotropy". Annual Transactions - The Nordic Rheology Society, vol. 28, p 8.

Skorpa, R., Vrålstad, T. 2017. "Visualization of Fluid Flow through Cracks and Microannuli in Cement Sheaths". Submitted to SPE Journal.

Suter, E., Cayeux, E., Friis, H.A., Kårstad, T., Escalona, A., Vefring, E.H. 2017. "A Novel Method for Locally Updating an Earth Model While Geosteering". International Journal of Geosciences, vol 8, p 237-264.

Torsvik, A., Skogestad, J.O. and Linga, H. 2017. "An Experimental Study of Gas Influx in Oil-Based Drilling Fluids for Improved Modelling of High-Pressure, High-Temperature Wells". Paper SPE 178860, SPE Journal. ISSN1064-6671.

Udegbunam, J.E., Fjelde, K.K., Evje, S., Nygard, G. 2015. "On the advection-upstream-splitting-method hybrid scheme: A simple transient-flow model for managed-pressure-drilling and underbalanced-drilling applications". SPE Drilling & Completions.

Zhou, J., Gravdal, J. E., Strand, P., Hovland, S. 2016. "Automated Kick Control Procedure for an Influx in Managed Pressure Drilling". Journal of Modelling, Identification and Control (MIC) - special edition on Offshore Technology.

Zhou, J., Krstic, M. 2016. "Adaptive Predictor Control for Stabilizing Pressure in a Managed Pressure Drilling System under Time-delay". Journal of Process Control, vol 40, pp 106-118.

CONFERENCE PAPERS WITH REVIEW

Aarsnes, U.J.F., Di Meglio, F., Shor, R. 2018. "Benchmarking of Industrial Stick-Slip Mitigation Controllers". Presented at the 3rd IFAC Workshop on Automatic Control in Offshore Oil and Gas Production OOGP, May 30- June 1, Esbjerg, Denmark.

Cayeux, E., Skadsem, H.J. 2014. "Estimation of weight and torque on bit: Assessment of uncertainties, correction and calibration methods". OMAE2014-23866 presented at the ASME 2014 International Conference on Ocean, Offshore and Arctic Engineering, OMAE2014, San Francisco, California.

Cayeux, E., Skadsem, H.J. 2017. "Modelling of the Dynamic Behavior of the Power Tansmission of an Automatic Small Scale Drilling Rig". In Proceedings of the ASME 2017 36th International Conference on Ocean, Offshore and

Arctic Engineering, OMAE, June 25-30, Trondheim, Norway.

Cayeux, E., Leulseged, A. 2018. "Modelling of Drilling Fluid Thixotropy". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

De Andrade, J., Sangesland, S., Vrålstad, T., Golan, M. 2014. ''Cement sheath integrity implications of scaled-down wellbore casing-cement-formation sections''. OMAE2014-24266 presented at the ASME 2014 International Conference on Ocean, Offshore and Arctic Engineering, OMAE2014, San Francisco, California.

Divyankar, S., Khatibi, M., Time, R.W., Skadsem, H.J., Aasen, J.Aa. 2018. "Experimental and CFD Study of Circulation Efficiency in Simulated Irregular Annulus". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Ghauri, A.A, Fjelde, K.K., Frøyen, J. 2016. ''A Transient Model for Hydraulic Simulation of Bullheading and Pressurized Mud Cap Drilling''. OMAE2016-54293. Proceedings of the 35th International Conference on Ocean, Offshore and Arctic Engineering, June 19-24, Busan, South Korea.

Gomes, D., Bjørkevoll, K., Frøyen, J., Fjelde, K.K., Sui, D., Udegbunam, J.E., Moeinika, F. 2017. ''Probabilistic Flow Modelling Approach for Kick Tolerance Calculations''. In Proceedings of the ASME 2017 36th International Conference on Ocean, Offshore and Arctic Engineering, OMAE, June 25-30, Trondheim, Norway.

Gomes, D. Nilsen, M., Frøyen, J., Bjørkevoll, K.S., Lage, A., Fjelde, K., Sui, D. 2018. "A Numerical Comparison and Uncertainty Analysis of Two Transient Models for Kick Management in a Backpressure MPD System". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Gomes, D., Nilsen, M., Frøyen, J., Bjørkevoll, K.S., Lage, A., Fjelde, K., Sui, D. 2018. ''A Transient Flow Model for Investigating Parameters Affecting Kick Behavior in OBM for HPHT Wells and Backpressure MPD Systems". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Iversen, F., Thorogood, J.L., Macoerhson, J.D., Macmillan, R. 2016. ''Business Models and KPIs as Drivers for Drilling Automation''. Presented at SPE Intelligent Energy International Conference and Exhibition, 6-8 September, Aberdeen, Scotland, UK. SPE-181047-MS. DOI 10.2118/181047-MS.

Kragset, S., Skadsem, H.J. 2018. ''Effect of Buoyancy and Inertia on Viscoplastic Fluid-Fluid Displacement in an Inclined Eccentric Annuluis with an Irregular Section". Presented at the ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Liu, Y., Arntsen, B., Wapenaar, K., van der Neut, J. 2014. ''Combining inter-source seismic interferometry and source-receiver interferometry for deep local imaging''. Society of Exploration Geophysicists conference, Denver, SEG Technical Program, pp 5107-5112.

Liu, Y., van der Neut, J., Arntsen, B., Wapenaar, K. 2015. ''Data-driven deep local imaging using both surface and borehole seismic data''. Society of Exploration Geophysicists conference, Denver, SEG Technical Program, pp 5554-5559.

Lund, B., Ytrehus, J. D., Taghipour, A. et al. 2018. "Fluid-fluid displacement for primary cementing in deviated washout sections". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Moeinikia, F., Fjelde, K.K., Sørbø, J., Saasen, A., Vrålstad, T. 2015. ''A Study of Possible Solutions for Cost Efficient Subsea Abadonment''. Paper OMAE2015-41261, St. Johns, Canada, June.

Myrseth, V.O., Werner B., Lund B., Saasen A., Ytrehus J.D. 2015. ''Rheological properties of oil based drilling fluids and base oils''. Paper OMAE2015-41901, St. Johns, Canada, June.

Opedal, N.; Corina, A.N., Vrålstad, T. 2018. "Laboratory Test on Cement Plug Integrity". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Sayindla, S., Lund, B., Taghipour, A., Werner, B., Saasen, A., Gyland, K.R., Ibragimova, Z., Ytrehus, J.D. 2016. ''Experimental investigation of Cuttings Transport with Oil Based Drilling Fluids''. Proceedings of the 35th International Conference on Ocean, Offshore and Arctic Engineering, June 19-24, Busan, South Korea.

Skadsem, H.J., Saasen, A., Håvardstein, S. 2017. ''Casing centralization in irregular wellbores''. OMAE2017-61106, OMAE2017 June 25-30, Trondheim, Norway.

Skorpa, R., Øia, T., Taghipour, A., Vrålstad, T. 2018. "Laboratory Set-Up for Determination of Cement Sheath Integrity during Pressure Cycling". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Strand, G.O. 2018. "On Technologies for Shale barrier Evaluation in the North Sea". Presented at ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Taghipour, A., Opedal, N., Skorpa, R., Vrålstad, T. 2017. ''Improved Laboratory Set-up for Pressurized and Confined Cement Sheath Integrity Tests''. OMAE2017-62444, Proceedings of the ASME 2017 36th International Conference on Ocean, Offshore and Arctic Engineering. OMAE2017 June 25-30, Trondheim, Norway.

Udegbunam, J.E., Sui, D., Moeinikia, F., Lage, A.C.V.M., Fjelde, K.K., Arild, Ø., Rabenafimanantsoa, H.A., Nygaard, G.H. 2017. ''A transient Flow Model for Predicting Pressure Buildup in Closed Annuli''. OMAE2017-62444, Proceedings of the ASME 2017 36th International Conference on Ocean, Offshore and Arctic Engineering. OMAE2017 June 25-30, Trondheim, Norway

Werner, B., Oltedal, V. M., Lund, B., Saasen, A., Ibragimova, Z., Ytrehus, J.D., Gyland, K.R. 2016. ''Effects of Oil-Based Drilling Fluid Rheological Properties on Hole Cleaning Performance''. Proceedings of the 35th International Conference on Ocean, Offshore and Arctic Engineering, June 19-24, Busan, South Korea.

Ytrehus, J.D., Taghipour, A., Sayindla, S., Lund, B., Werner, B., Saasen, A. 2015. ''Full scale flow loop experiments of hole cleaning performances of drilling fluids''. Paper OMAE2015-41901, St. Johns, Canada, June.

Ytrehus, J.D., Lund, B., Taghipour, A., Divyankar, S. 2017. ''Experimental Investigation of Wellvore Fluid Displacement in Concentris and Eccentric

Annulus". OMAE2017 June 25-30, Trondheim, Norway.

Aarsnes, U.J.F., Wouw, N.v.d., Detournay, E., Denoel, V. 2018. "Proceedings of the Fourth International Colloquium on Nonlinear Dynamics and Control of Deep Drilling Systems". Fourth International Colloquium on Nonlinear Dynamics and Control of Deep Drilling Systems, May 14.-16.

BOOK

Aarsnes, U.J.F., Wouw, N.v.d., Detournay, E., Denoel, V. 2018. "Proceedings of the Fourth International Colloquium on Nonlinear Dynamics and Control of Deep Drilling Systems". Fourth International Colloquium on Nonlinear Dynamics and Control of Deep Drilling Systems, May 14.-16.

CONFERENCE WITH PAPER

Arild, Ø., Lohne, H.P., Nilsen, M., Moeinikia, F., Selvik, J.T., Abrahamsen, E. B., Ford, E. P., Majoumerd, M. M. 2018. "Permanent P&A Design - What is Good Enough?". SPE-191414-MS: SPE Annual Technical Conference and Exhibition, Dallas, Texas, USA, September 4-26.

Aarsnes, U.J.F., Hauge, E., Godhavn, J.M. 2016. ''Mathematical Modeling of Gas in Riser''. SPE Deepwater Drilling & Completions Conference held in Galveston, Texas, USA, 14–15 September.

Aas, B., Sørbø, J., Stokka, S., Saasen A., Godøy, R., Lunde, Ø., Vrålstad, T. 2016. ''Cement Placement with Tubing Left in Hole during Plug and Abandonment''. Paper IADC/SPE-178840 at the SPE Drilling conference in Fort Worth, TX, USA, March 1-3.

Abrahamsen, E.B., Selvik, J.T. 2013. ''A framework for selection of inspection intervals for well barriers''. ESREL conference, London, 29 September-2 October.

Albawi, A., De Andrade, J., Torsæter, M., Opedal, N., Stroisz, A, Vrålstad, T. 2014. ''Experimental Set-Up for Testing Cement Sheath Integrity in Arctic Wells''. OTC 24587, presented at the Arctic Technology Conference, Houston.

Askarinezhad, R., Hatzignatiou, D. 2016. ''Water-Soluble Silicate Gelants for Disproportionate Permeability Reduction: Importance of Formation Wetting and Treatment Conditions''. Presented at the International Symposium of the Society of Core Analysts, Snowmass, Colorado, USA, 21-26 August.

Askarinezhad, R., Hatzignatiou, D. 2016. ''Water-soluble silicate gelants for disproportionate permeability reduction: Importance of formation wetting and treatment conditions''. Paper prepared for presentation at the International Symposium of Society of Core Analysts, Colorado, USA, 21-26 August.

Askarinezhad, R., Hatzignatiou, D.G., Stavland, A. 2016. ''Disproportionate Permeability Reduction of Water-Soluble Silicate Gelants – Importance of Formation Wettability''. Paper SPE 179589-MS presented at the SPE Improved Oil Recovery Conference, Tulsa, Oklahoma, April 9-13.

Askarinezhad, E., Hatzignatiou, D. 2017. ''Improved Disproportionate Permeability Reduction of Silicate-Gelant Treatments: A Laboratory Scale Approach''. Prepared for presentation at SPE International Conference on Oilfield Chemistry, Montgomery, Texas, April 3-5.

Bjørkevoll, K., Daireaux, B., Berg, P.C. 2015. ''Possibilities, Limitations and Pitfalls in Using Real-Time Well Flow Models During Drilling Operations''. SPE One Day Seminar, Bergen.

Bjørkevoll, K., Skogestad J.O., Froyen J., Linga H. 2018. "Well Control Simulator: Enhancing Models With Compositional PVT Models and Kinetics". SPE Drilling Conference, Fort Worth, Texas, USA, March 6-8.

Bjørkevoll, K., Skogestad, J.O., Frøyen, J., Linga, H. 2018. "Enhanced Well Control Potential with Along-String Measurements". Paper SPE-191326-MS, SPE Norway One Day Seminar, Bergen, Norway, April 18.

Cayeux, E., Mesagan, T., Tanripada, S. Zidan, M. and Fjelde, K.K. 2013. ''Real-time Evaluation of Hole Cleaning Conditions Using a Transient Cuttings Transport Model''. SPE-163492-MS presented at POE/IADC Amsterdam.

Cayeux, E., Lande, H.P. 2013. ''Factors Influencing the estimation of downhole pressure far away from measurement points during drilling operations''. 54rd SIMS in Bergen.

Cayeux, E., Daireaux, B., Dvergsnes, E.W., Siahaan, H., Gravdal, J.E. 2014. ''Principles and Sensitivity Analysis of Automatic Calibration of MPD Methods Based on Dual-Gradient Drilling Solutions''. SPE Deepwater Drilling and Completions Conference held in Galveston, 10-11 Sep.

Cayeux, E., Skadsem, H.J., Kluge, R. 2015. ''Accuracy and Correction of Hook Load Measurements During Drilling Operation''. SPE/IADC Drilling Conference and exhibition, London, March 17-19.

Cayeux, E., Daireaux, B., Balov, M.K., Haavardstein, S., Stokland, L.M., Saasen, A. 2016. ''Automatic Performance Analysis and Estimation of Risk Level Embedded in Drilling Operation Plans''. Paper SPE-181018 prepared for presentation at the SPE Intelligent Energy International Conference and Exhibition held in Aberdeen, United Kingdom, 6–8 September.

Cayeux, E., Leulseged, A., Kluge, R., Haga J. 2016. ''Use of a Transient Cuttings Transport Model in the Planning, Monitoring and Post Analysis of Complex Drilling Operations in the North Sea''. Paper IADC/SPE-178862 presented at the SPE Drilling conference in Fort Worth, TX, USA, March 1-3.

Cayeux, E., Daireaux, B., Mihai, R. 2017. ''Automatic Risk Uncertainty Estimation to Support Decission Making during Drilling Operation Planning: Case Study on an ERD Well''. Oil and Gas European Magazine, vol 1, January.

Cayeux, E., Daireaux, B., Skadsem, H.J., Holand, R. 2017. ''Challenges and Solutions to the Correct Interpretation of Drilling Friction Tests''. SPE Drilling Conference in The Hague.

Cayeux, E. 2018. "Reconstruction of Pipe Displacement Based on High-Frequency Triaxial Accelerometer Measurements". SPE-189618-MS: presented at SPE Drilling Conference, Fort Worth, Texas, USA, March 6-8.

Cayeux, E. 2018. "On the Importance of Boundary Conditions for Real-time Transient Drill-string Mechanical Estimations". SPE-189642-MS: presented at SPE Drilling Conference, Fort Worth, Texas, USA, March 6-8.

Cayeux, E., Skadsem, H.J., Carlsen, L.A., Stokland, L.M., Cruikshank, S. 2018. "Analysis of Asymmetric Tool-joint Wear whtile Drilling Long Horizontal Sections". SPE-191339-MS, presented at SPE Norway One Day Seminar, Bergen, Norway, April 18.

Cayeux, E. 2018. "Drill-string dynamics in deviated wells in the presence of heave". Presented at DCDS Colloquium, Preikestolen, Stavanger, Norway, May 14-16.

Cerasi, P. 2018. "Evaluation of uncertainty in mudweight window from error propagation considerations"10º Congreso de Exploración y Desarrollo de Hidrocarburos, November 7-9. Mendoza, Argentina.

Chen, Y., Lorentzen, R.J., Vefring, E. 2012. ''Optimization of Well Trajectory under Uncertainty for Proactive Geosteering''. ECMOR XII-13th European Conference on the Mathematics of Oil Recovery.

Chen, Y., Luo, X., Vefring, E. 2014. ''On bias correction for parameter estimation problems with applications to model updating for geosteering''. ECMOR XIV-14th European Conference on the Mathematics of Oil Recovery.

Daireaux, B., Cayeux, E., Haavardstein, S., Stokland, L.M. 2017. ''Use of Quantitative Risk Analysis Methods to Determine the Expected Drilling Parameter Operating Window Prior to Operation Start: Example from two Wells in the North Sea''. SPE Drilling Conference in The Hague.

De Andrade, J., Sangesland, S., Todorovic, J., Vrålstad, T. 2015. ''Cement Sheath Integrity During Thermal Cycling: A Novel Approach for Experimental Tests of Cement Systems''. Paper SPE-173871-MS presented at the SPE One Day Seminar, Bergen, April 22.

De Andradee, J., Torsæter, M., Sangesland, S., Todorovic, J., Opedal, N., Stroisz, A., Vrålstad T. 2014. ''Influence of Casing Centralization on Cement Sheath Integrity During Thermal Cycling''. IADC/SPE Drilling Conference, Fort Worth.

Di Meglio, F., Aarsnes, U.J.F., Shor, R. 2018. "Advances in Control of Hyperbolic Partial Differential". Fourth International Colloquium on Nonlinear Dynamics and Control of Deep Drilling Systems, May 14-16.

Fjelde, K.K., Frøyen, J., Ghauri, A.A. 2016. ''A Numerical Study of Gas Kick Migration Velocities and Uncertainty''. Paper SPE-180053 presented at the SPE One Day Seminar, Bergen, April 20.

Fjelde, K.K., Frøyen, J., Ghauri, A.A. 2016. ''A Numerical Study of Gas Kick Migration Velocities and Uncertainty''. Presented at SPE Bergen One Day Seminar, 20, April 2016, Grieghallen, Bergen, Norway. SPE 180053.

Flatebø, G.Ø., Torsvik, A., Oltedal, V.M., Bjørkvik, B., Grimstad, A.A., Linga, H. 2015. ''Experimental Gas Absorption in Petroleum Fluids at HPHT Conditions''. SPE 173865-MS presented at SPE One Day Seminar, Bergen, April 22.

Ford, E., Moeinkia, F., Mansouri, M., Lohne, H.P., Arild, Ø. 2018. "Consequence Quantification of Barrier System Failures in Permanently". SPE-191298-MS, presented at SPE Norway One Day Seminar, Bergen, Norway, April 18.

Gardner, D, Pirovolou, D. 2018. "An Experimental Facility for Evaluating Well Barrier Verification Technology". SPE-191300-MS, presented at SPE Norway One Day Seminar, Bergen, Norway, April 18.

Gomes, D., Frøyen, J, Fjelde, K.K., Bjørkevoll, K. 2018. "A Numerical Comparison and Uncertainty Analysis of Two Transient Models for Kick Management in a Backpressure MPD System". SPE-191345-MS, presented at SPE Norway One Day Seminar, Bergen, Norway, April 18.

Gomes, D., Frøyen, J., Fjelde K.K., Bjørkevoll, K. S. 2018. "A Transient Modelling and Sensitivity Analysis of Influxes in Backpressure MPD Systems". SPE-192101-MS: presented at SPE Asia Pacific Oil & Gas Conference in Brisbane, Australia, October 23-25.

Gravdal, J.E., Siahaan, H. Bjørkevoll, K.S. 2014. ''Back-Pressure Managed Pressure Drilling in Extended-Reach Wells – Limiting factors for the ability to achieve accurate pressure control''. SPE 169211, SPE One Day Seminar, Bergen.

Grimstad, A.A., Linga H., Saasen, A., 2017. ''Degassing rate of drilling fluid base oils as exposed to depressurisation and drill string rotation''. SPE Drilling Conference in The Hague.

Hatzignatiou, D.G., Askarinezhad, R., Giske, N., Stavland, A. 2015. ''Laboratory Testing of Environmentally Friendly Chemicals for Water Management''. SPE One Day Seminar, Bergen, April 22.

Khalifeh, M., Hodne, H., Korsnes, R.I., Saasen, A. 2015. ''Cap rock restoration in plug and abandonment operations; Possible utilization of rock-based geopolymers for permanent zonal isolation and well plugging''. IPTC-18454-MS presented at the international Petroleum Technology Conference (IPTC), Doha, Qatar.

Khalifeh, M., Saasen, A., Hodne, H., Vrålstad, T. 2013. ''Techniques and Materials for North Sea Plug and Abandonment Operations''. Offshore Technology Conference, Houston, 6-9 May.

Khalifeh, M., Saasen, A., Vrålstad, T., Hodne, H. 2014. ''Potential Utilization of Geopolymers in Plug and Abandonment Operations''. SPE 169231-MS presented at the SPE Bergen One Day Seminar, Bergen.

Khalifeh, M., Saasen, A., Vrålstad, T., Larsen, H.B., Hodne, H. 2015. ''Cap rock restoration in plug and abandonment operations; Possible utilization of aplite-based geopolymers for permanent zonal isolation and well plugging''. SPE Offshore Europe Conference and Exhibition, Aberdeen.

Kullawan, K., Bratvold, R., Bickel, J.E. 2013. ''A Decision Analytic Approach to Geosteering Operations''. Paper SPE 167433 presented at the SPE Middle East Intelligent Energy Conference and Exhibition, Dubai, October 28-30.

Kullawan, K., Bratvold, R., Bickel, J.E. 2014. ''Value Creation with Multi-Criteria Decision Making in Geosteering Operations''. SPE Hydrocarbon Economics and Evaluation Symposium, Houston.

Linga, H., Torsvik, A., Oltedal, V.M., Saasen, A. 2016. ''Kick Detection Capability of Oil-based Muds in Well Control Situations''. Paper SPE-180039 presented at SPE One Day Seminar, Bergen, April 20.

Linga, H., Bjørkevoll, K. S., Mortensen, H. Saasen, A. 2017. ''Gas influx in drilling fluid during flow check operation as affected by gas absorption characteristics of the drilling fluid. ''. SPE Drilling Conference in The Hague.

Liu, Y., Arntsen, B., Wapenaar, K., Romdhane, A. 2014. ''Inter-source seismic interferometry by multidimensional deconvolution (MDD) for borehole sources''. Bejing 2014 International Geophysical Conference & Exposition.

Liu, Y., Draganov, D., Wapenaar, K., Arntsen, B. 2015. ''Creating Virtual Receivers from Drill-bit Noise''. WS15-A02. In 77th EAGE Conference and Exhibition Workshop.

Liu, Y., Wapenaar, K., Arntsen, B. 2014. ''Turning Subsurface Noise Sources into Virtual Receivers by Multi-dimensional Deconvolution''. 76th EAGE Conference and Exhibition, Amsterdam.

Liu, Yi, Arntsen, B., Landrø, M., van der Neut, J., Wapenaar, K. 2016. ''New method for discriminating 4D time shifts in the overburden and reservoir''. SEG Technical Program Expanded Abstracts, Dallas, pp 5521-5526.

Liu, Yi, Arntsen, B., van der Neut, J., Wapenaar, K. 2016. ''Auto-estimation of Up-down Wavefields in a Horizontal Borehole using Single Component Data''. 78th EAGE Conference and Exhibition, Vienna.

Lothe, A.E., Cerasi, P, Haavardstein, S., Bjørkevoll, K.S. 2017. ''Workflow for Uncertainty Modelling of Pore Pressure and Mud Weight Window ahead of Bit - Example of Pre-drill Results from the North Sea''. Prepared for presentation at EAGE Workshop on Pore Pressure Prediction, 19-21 March, Pau, France.

Lothe, A.E., Cerasi, P., Bjørkevoll, K.S., Haavardstein, S.2018. "Digitized Uncertainty Handling of Pore Pressure and Mud-Weight Window Ahead of Bit; Example North Sea". Presented at IADC/SPE Drilling Conference and Exhibition, Fort Worth, Texas, USA, March 6-8.

Luo, X., Eliasson, P., Alyaev, S., Romdhane, A., Suter, E., Querendez, E., Vefring, E. 2015. ''An ensemble-based framework for proactive geosteering''. Proceeding of SPWLA Symposium, Long Beach, California, July 18-22.

Moeinikia, F., Fjelde, K.K., Saasen, A., Vrålstad, T. 2014. ''An Investigation of Different Approaches for Probabilistic Cost and Time Estimation of Rigless P&A in Subsea Multi-Well Campaign''. Paper SPE 169203 presented at the SPE Bergen One Day Seminar, April 2.

Moeinikia, F., Fjelde, K.K., Saasen, A., Vrålstad, T. 2014. ''Evaluating Cost Efficiency of Rigless P&A for Subsea Multiwell Campaign''. Paper IADC/SPE 167923 presented at the IADC/SPE Drilling Conference and Exhibition held in Fort Worth, Texas, 4–6 March.

Moeinikia, F., Fjelde, K.K., Saasen, A., Vrålstad, T. 2015. ''Essential Aspects in Probabilistic Cost and Duration Forecasting for Subsea Multi-well Abandonment: Simplicity, Industrial Applicability and Accuracy''. Paper SPE-173850-MS presented at the SPE One Day Seminar, Bergen, April 22.

Opedal, N., Todorovic, J., Torsæter, M., Vrålstad, T., Mushtaq, W. 2014. ''Experimental Study on the Cement-Formation Bonding''. Paper SPE 168138-MS presented at the SPE International Symposium on Formation Damage Control, Lafayette, Louisiana, USA, 26–28 February.

Paglio, J., Eidsvik, J., Grøver, A., Lothe. A.E. 2018. "Online spatial pore pressure prediction from well logs". Presented at the 80th EAGE Conference & Exhibition 2018, Copenhagen, Denmark, June 11-14.

Petersen, J. 2018. "SPE-189617-MS: The Impact of Molecular Diffusion of Methane into Wells with Oil Based Mud". Presented at IADC/SPE Drilling Conference and Exhibition, Fort Worth, Texas, USA, March 6-8.

Renteria, A., Maleki, A., Frigaard, I. A., Lund, B., Taghipour, A., Ytrehus, J. D. 2018. "TBC: Effects of irregularity on displacement flows in primary cementing of highly deviated wells". Presented at the SPE Asia Pacific Oil & Gas Conference and Exhibition, Brisbane, October 23-25.

Romdhane, A., Querendez, E. and Helset, H.M 2012. ''FWI for Sub-surface Imaging in the Context of Seismic while Drilling-Synthetic Study''. Presented at the 74th EAGE Conference & Exhibition, 4-7 June.

Shor, R., Aarsnes, U.J.F, Di Meglio, F. 2018. "Effects of latency, motor inertia and filtering on stick-slip mitigation control". Presented at the Fourth International Colloquium on Nonlinear Dynamics and Control of Deep Drilling Systems, May 14-16.

Skadsem, H.J., Aasen, J.A. 2018. "Transforming the Concentric Annulus to a Finite Width Duct for Laboratory Measurements of Wellbore Flows". SPE-191306-MS, presented at the SPE Norway One Day Seminar, Bergen, Norway, April 18.

Skogestad J. O., Linga H., Bjørkevoll, K. S., Saasen, A. 2017. ''Predicting Gas Loading Capability in Oil-based Drilling Fluids.''. Presented at the SPE Drilling Conference in The Hague.

Saasen, A., Fjelde, K.K., Vrålstad, T., Moeinikia, F. 2013. ''Plugging and Abandonment of Offshore Exploration Wells''. Paper OTC 23909 presented at the Offshore Technology Conference, Houston, 6-9 May.

Selvik, J.T., Abrahamsen, E.B. 2013. ''How to describe well barrier reliability: A SCSSV review study''. Presented at the COMDEM 2013 conference, Helsinki, June 11-13.

Siahaan, H., Bjorkvoll, K.S., Gravdal, J.E. 2013. ''Possibilities of Using Wired Drill Pipe Telemetry During Managed Pressure Drilling in Extended Reach Wells''. Paper SPE 167856 presented at the SPE Intelligent Energy Conference and Exhibition, Utrecht, April 1-3.

Skorpa, R., Vrålstad, T. 2015. ''Visualization and Quantification of Fluid Flow Through Degraded Cement Sheaths''. Paper SPE-180019-MS presented at the SPE One Day Seminar, Bergen, April 20.

Skorpa, R., Vrålstad, T. 2016. ''Visualization and Quantification of Fluid Flow Through Degraded Cement Sheaths''. Paper SPE-180019-MS, prepared for presentation at the SPE One Day Seminar, Bergen, April 20.

Suter, E., Cayeux, E., Escalona, A., Kårstad, T., Vefring, E.H. 2012. ''A Strategy for Effective Local Updates of the Geological Structure in an Earth Model during Drilling''. Extended abstract D035, presented at the 74th EAGE Conference and Exhibition incorporating SPE Europec 2012 in Copenhagen, Denmark, 4-7 June.

Suter, E., 2017. ''A Method for Multi-Scale Earth Modelling''. SPE Reservoir Simulation Conference Feb 20-22, Conference Center at La Torretta Montgomery, Texas, USA.

Suter, E., Friis, H.A., Vefring, E.H., Kårstad, T., Escalona, A. 2017. ''A novel method for multi-resolution earth model gridding''. SPE-182687-MS. Presented at the SPE Reservoir Simulation Conference held in Montgomery, TX, USA 20–22 February.

Torsvik, A., Myrseth, V., Linga, H. 2015. ''Drilling fluid rheology at challenging drilling conditions –an experimental study using a 1000 bar pressure cell''. presented at the Nordic Rheology Conference in Karlstad, Sweden, August 19-20. Paper published in Annual Transactions of the Nordic Rheology Society.

Torsvik, A., Skogestad, J.O., Linga, H. 2016. ''Impact on Oil-Based Drilling Fluid Properties from Gas Influx at HPHT conditions''. Paper IADC/SPE-178860 presented at the coming SPE Drilling conference in Fort Worth, TX, USA, March 1-3.

Torsæter, M., Opedal, N., Vrålstad, T., Vullum, P.E 2013. ''A Visual Journey into the 3D Chemical Nanostructure of Oilwell Cement''. Paper SPE 164105 presented at the SPE International Symposium on Oilfield Chemistry held in The Woodlands, Texas, USA, 8–10 April.

Valestrand, R., Khrulenko, A., Hatzignatiou, D.G. 2014. ''Smart Wells for Improved Water Management in the Presence of Geological Uncertainty''. Paper SPE 169223 presented at the SPE Bergen One Day Seminar, April 2.

Vrålstad, T., Skorpa, R., Opedal, N., De Andrade, J. 2015. ''Effect of thermal cycling on cement sheath integrity: Realistic experimental tests and simulation of resulting leakages''. SPE-178467-MS presented at the SPE Thermal Well Integrity and Design Symposium, Alberta, Canada, November 23-25.

Vrålstad, T., Todorovic, J., Saasen, A., Godøy R. 2016. ''Long-term Integrity of Well Cements at Downhole Conditions''. Paper SPE-180058-MS presented at the SPE One Day Seminar, Bergen, April 20.

PRESENTATIONS WITHOUT PAPER

Aarsnes, U.J.F.,Van de Wouw, N. 2017. ''Axial and torsional dynamics of a distributed drill string system''. 9th European Nonlinear Dynamics Conference.

Aarsnes, U.J.F., Roman Shor 2017. ''Stick-slip and Torsional Friction Factors in Inclined Wellbores''. International Conference on Engineering Vibration, Sofia, Bulgaria, September 4-7.

Aarsnes, U.J.F., Van de Wouw, N. 2017. ''Axial and torsional dynamics of a distributed drill string system''. European Nonlinear Dynamics Conference (ENOC), June 25-30, Budapest, Hungary.

Aas, B. 2014. ''Plugging and abandonment with tubing left in hole''. Presented at P&A Forum, Stavanger, June.

Aas, B. 2014. ''The DrillWell project – Tubing left in hole''. Presented at the Kristiansand Drilling and Well Conference, NPF, September 16.

Arild, Ø. 2018. "P&A leakage risk assessment". Presented at The annual DrillWell seminar, Stavanger, September 25-26.

Arild, Ø. 2018. "Discussion of acceptance criteria for risk-based P&A design". P&A Seminar 2018, Stavanger, October 18.

Askarinezhad, R., Hatzignatiou, D., Stavland, A. 2016. ''Improved Disproportionate Permeability Reduction Treatment Process: A Laboratory Scale Approach''. Presented at the NPF conference: Reservoir & Production Management, Stavanger, November 28-29, 2016.

Bjørkevoll, K. 2018. "Well Control Simulator". Presented at The annual DrillWell seminar, Stavanger, September 25-26.

Cayeux, E. 2014. ''Getting it Right: Balancing Model Complexity, Margin and Risk with the Right Measurements''. Key Note at Celle Drilling International Conference and Exhibition for Advanced Drilling Technology (SPE/IADC), September 15-16.

Cayeux, E. 2016. ''Cutting transport and drilling optimization''. Presented at The annual DrillWell seminar, Sola Strand Hotel - September 27-28.

Cayeux, E. 2016. ''Requirements for data transfer in a multivendor environment to support drilling automation''. Presented at the Morning Seminar – Data for Drilling Automation, at IRIS, Stavanger, 24 May.

Cayeux, E., Daireaux, B., Mihai, R. 2016. ''Automatic Risk Uncertainty Estimation to Support Decission Making during Drilling Operation Planning: Case Study on an ERD Well''. Celle Drilling Conference, Celle, Germany, September 12-13.

Cayeux, E. 2017. ''Model-driven Drilling Process Automation: Design Considerations and Results from Drilling 17 Sections in the North Sea''. SPE Workshop: The Great Drilling Automation Debate, April 19-20. Invited speaker.

Cayeux, E. 2017. ''Insights Into the Physical Phenomena That Influence Automatic Gain Loss Detection During Drilling Operations''. SPE Webinar Petroleum.

Cayeux, E. 2018 "Digitalization – Interoperability for Drilling Real-time Management and Control: The Drilling Data Hub Initiative". Presented at the evening meeting of the Norwegian Petroleum Society, Stavanger section, May 29.

Cayeux, E. 2018. "Mot sømløs datautveksling mellom sanntids boreprosesstyring og kontrollapplikasjoner». Presented at Borekonferansen i Kristiansand, September 17-19.

Cayeux, E. 2018. "Impact of solids particles on the apparent rheological behavior for drilling fluids". Presented at The annual DrillWell Seminar, Stavanger, September 25-26.

Cayeux, E. 2018. «Interpretation of along-string accelerometer data». Presented at The annual DrillWell Seminar, Stavanger, September 25-26.

Cayeux, E., Stokland, L. 2018. «Tool Joint Wear". Presented at The annual DrillWell, seminar, Stavanger, September 25-26.

Cerasi, P., Lothe, A.E. 2018. "Drilling in the Barents Sea: What to expect". Presented at ONS, Stavanger, August 27-30.

Corina, A.N. 2018. "Effect of casing surface roughness on cement plug sealing ability". Presented at The annual DrillWell seminar, Stavanger, September 25-26.

Daireaux, B. 2018. "Drilling Data Hub". Presented at The annual DrillWell seminar, Stavanger, September 25-26.

Flornes, K. 2015. ''Improved recovery and the National IOR Centre of Norway''. Stavanger meeting, Politicians and Industry.

Flornes, K. 2015. ''Innovations for cost reduction''. NPF Stavanger.

Flornes, K. 2016. ''P&A R&D''. Presented at Stortinget, February.

Gardner, D. 2016. ''Ongoing P&A Research in DrillWell''. Presented at the NorTex Data Science Cluster Workshop: Plug & Abandonment, OTC, Houston, 5 May.

Gardner, D. 2016. ''Reducing the cost of Well abandonment''. Celle Drilling Conference, Celle, Germany, September 12-13.

Gardner, D. 2016. ''DrillWell P&A projects''. Presented at the DEA meeting, St.

Andrews, Scotland, 15-16 September.

Gardner, D. 2016. ''Test facility for cement evaluation''. Presented at The annual DrillWell seminar, Sola Strand Hotel - September 27-28.

Gardner, D. 2016. ''Overview of P&A innovations''. Presented at NPF conference: Reservoir & Production Management, Stavanger, November 28-29, 2016.

Gardner, D. 2017. ''Cement barrier evaluation lab''. SINTEF Conference - Experimental P&A research for the North Sea, March 20-21, Trondheim.

Gardner, D. 2017. ''Well P&A, evaluating the barrier system quality''. Kristiansandkonferansen innen boring og brønn.

Gardner, D. 2018. "P&A Technology Testing Facility". Presented at the PACE Plugging & Abandonment Collaborative Environment, Tulsa, USA, April 11.

Gardner, D. 2018. "Cement performance evaluation testing with a new broad spectrum acoustic tool". Presented at The annual DrillWell Seminar, Stavanger, September 25-26.

Gjeraldstveit, H., 2016. ''Strategi for industristrisamarbeid og innovasjon – erfaringar frå SFI «DrillWell». SFI-forum Norges Forskningsråd, 28 April.

Gravdal, J.E. 2016. ''Goals for the NorTex data science cluster – Drilling & Well Technology''. Presented at the NorTex Drilling and Well Conference and Workshop: Digitalization and Integrated Operations, OTC, Houston, May 2.

Gravdal, J.E. 2016. ''Virtual arena''. Presented at the NorTex Drilling and Well Conference and Workshop: Digitalization and Integrated Operations, OTC, Houston, May 2.

Grimstad, A.A. 2016. ''Gas release from drilling fluid during depressurization''. Presented at The annual DrillWell seminar, Sola Strand Hotel - September 27-28.

Grøver, A., Roli, O.-A. & Lothe, A.E. 2018. "New methodology for 3D geo-pressure modelling with multi burial and uplift effects". Poster at AAPG ICE, Cape Town, South Africa, November 4-7.

Hodne, H., 2017. ''Synthetic rock barriers, Geopolymers''. SINTEF Conference - Experimental P&A research for the North Sea, March 20-21, Trondheim.

Iversen, F. 2015. ''Cementing Irregular Wellbore Geometries''. Presented at DEA(e) Q1 2015 Network Meeting.

Iversen, F., Mihai, R. 2016. ''Automatic fluid measurement and efficiency benefits for drilling automation''. Presented at DEA€Europe Meeting Q1 2016, Vlaardingen.

Kullawan, K. 2012. ''Decision analysis for deep imaging and geo-steering''. Presented at Transatlantic Science Week, Rice University, Houston, USA, 12-16 Nov.

Khalifeh, M. 2018. "SafeRock as an alternative to cement for zonal isolation and P&A – Opportunities and barriers". Presented at The annual DrillWell Seminar, Stavanger, September 25-26.

Kullawan, K. 2016. ''Decision Analytics for Look-Ahead Decision-Making: Optimize Your Well and Save Your Money''. Presented at the SPE/EAGE Geosteering and Well Placement Workshop in Dubai on 8-10 February 2016.

Kullawan, K., Bratvold, R., Bickel, J.E. 2016. ''Decision Analytics for Look-Ahead Decision-Making: Optimize Your Well and Save Your Money''. SPE/EAGE Geosteering and Well Placement Workshop in Dubai on 8-10 February.

Lothe, A.E., 2017. ''Uncertainty in pore-pressure and mud-weight prediction ahead of bit''. Presented at The annual DrillWell seminar, Sola Strand Hotel - September 26-27.

Lothe, A.E. 2018. "Digitized uncertainty handling of pore pressure and mud-weight window ahead of bit; example North Sea". Guest presentation at the first Geomechanical Initiative: Challenges in wellbore stability, Milano, Italy, June 21-22.

Lothe, A.E. 2018. "Uncertainties in subsurface: effect on pore pressure prediction". SINTEF Petroleum Conference, Trondheim, March 21-22.

Lothe, A.E., Nes, O.M. 2018. "PressureAhead; from research project to field test". Presented at The annual DrillWell seminar, Stavanger, September 25-26.

Lund, B., 2016. ''Results from displacement experiments in irregular annulus geometries''. Presented at The annual DrillWell seminar, Sola Strand Hotel - September 27-28.

Moeinikia, F., Saasen, A., Raksagati, S., Fjelde, K.K., Vrålstad, T. 2013. ''Cost effective P&A Approach for Wellhead Removal in Offshore Exploration Wells and Methodology for Comparing Alternatives''. Presented at the SPE One Day Seminar, Bergen, April 10.

Paglia, J., Eidvik, J. 2017. ''Statistical modeling for online pore-pressure prediction and drilling window''. Poster at The annual DrillWell seminar, Sola Strand Hotel - September 26-27.

Skadsem, H.J. 2018. "Cementing Irregular Wellbore Geometries". Presented at the SPE February Meeting, 2018, Stavanger, February 7.

Skadsem, H.J. 2018. "Full-scale cementing experiments in an irregular annulus geometry". Presented at The annual DrillWell seminar, Stavanger, September 25-26.

Skorpa, R. 2018. "Cement sheath integrity during pressure cycling". Presented at The annual DrillWell seminar, Stavanger, September 25-26.

Stokka, S. 2012. ''Centre for Drilling and Wells for Improved Recovery''. Presented at the Transatlantic Science Week, Rice University, Houston, USA, 12-16 Nov.

Stokka, S. 2013. ''Centre for drilling and wells for improved recovery''. Presented at the Offshore Technology Day, Stavanger, October 23.

Stokka, S. 2014. ''Cost effective wells for improved oil recovery''. Presented at ONS Centre Court, Joining forces to recover more, 26 August.

Stokka, S. 2014. ''Drilling and Wells for Mature Fields''. Presented at the NPF conference: Mature Fields: Business Opportunities and Challenges", Stavanger, 1-2 April.

Stokka, S. 2015. ''P&A in DrillWell''. Poster presented at the P&A seminar, Sola, Stavanger, October 29.

Stokka, S. 2015. ''P&A in DrillWell''. Presented at the INTSOK UK – Norway Network meeting regarding decommissioning, Stavanger, May 20.

Stokka, S. 2015. ''P&A, fast and with low cost. P&A in DrillWell''. Presented at NPF Stavanger, April 21.

Stokka, S., 2017. ''Can tubing be left in hole?''. SINTEF Conference - Experimental P&A research for the North Sea, March 20-21, Trondheim.

Stokka, S. 2018. "DrillWell - Drilling and well centre for improved recovery". Presented at IOR Norway 2018 Conference, Stavanger, April 24-25.

Suter, E., Helset, H.M. 2012. ''The role of automation in improved decision support for optimal well placement''. Presented at the "Autonomy in the oil and gas industry" conference, Sola Strand hotel, Norway, 7-8 March.

Suter, E., Kårstad, T., Escalona, A. and Vefring, E.H. 2016. ''Decision Support For Proactive Geosteering Under Uncertainty''. SPE/EAGE Geosteering and Well Placement Workshop in Dubai on 8-10 February.

Suter, E.C. 2016. ''Decision Support for Proactive Geosteering Under Uncertainty''.
Poster at the SPE/EAGE Geosteering and Well Placement Workshop in Dubai on 8-10 February.

Suter, E.C. 2016. ''Decision Support for Proactive Geosteering Under Uncertainty''. Presented at the SPE/EAGE Geosteering and Well Placement Workshop in Dubai on 8-10 February.

Suter, E.C., Kårstad, T., Escalona, A., Vefring, E.H. 2016. ''A method for locally adaptive gridding and local updates of the geological structure in earth models''. Poster presented at the IOR Norway 2016 conference, Recover for the future, Stavanger, 27-28 April.

Suter, E., Alayev, S., Luo, X., Romdhane, A., Eliasson, P., Vefring, E.H. 2017. ''Proactive geosteering workflow for enhanced oil recovery''. Poster presented at the 17th Geilo Winter School: Machine learning, deep learning, and data analytics, January 15-20, Geilo, Norway.

Suter, E., Alayev, S., Daireuax, B. 2017. ''RT-Hub: next generation real-time data aggregation while drilling''. Poster presentation at EAGE Workshop on Pore Pressure Prediction, March 19-21, Pau, France.

Sælevik, G. 2018. "Digital Drilling». Presented at SPE February Meeting, Stavanger, February 7.

Vrålstad, T. 2014. ''Cement sheath integrity during thermal cycling''. SPE-173871-MS presented at DEA December 5.

Vrålstad, T. 2014. ''Thermal cycling of cement''. Presented at SPE Forum on Zonal isolation in Portugal, February.

Vrålstad, T. 2014. ''Thermal cycling of cement''. Presented at SPE Workshop on Cementing in Lyon, March.

Vrålstad, T. 2014. ''Thermal cycling of cement''. Presented at Well Integrity Forum, Sandnes, June 12.

Vrålstad, T., 2017. ''What is the sealing ability of plugs?''. SINTEF Conference - Experimental P&A research for the North Sea, March 20-21, Trondheim.

Zhou, J., Gravdal J.E., Strand, P., Hovland, S. 2014. ''Automatic Well Control Procedure for Kick Handling in Managed Pressure Drilling Operations Using PWD Data''. Presented at the IADC Well Control Europe Conference and Exhibition, Aberdeen, December 2-3.

Ølberg, T. 2011. ''Senter for Boring og Brønn for økt Utvinning (SBBU) - et verktøy for innovasjon og bidrag innen sikkerhet, verdiskaping og effektivitet''. Presented at the NPF drilling and well conference, Kristiansand, September.

MEDIA

Adjacent Oil and Gas Journal, Technology and Innovation 2016. ''Realistic simulator tools are crucial to reduce drilling costs'', October Edition.

Adjacent Oil and Gas Journal, Technology and Innovation 2015. ''Model based drilling software'', November Edition.

Aftenposten 2013. ''Eldrebølgen på norsk sokkel'', November.

Drilling Contractor, Interview with Jing Zhou 2014. ''Case study: Automatic kick control reduces kick size, time to establish control of well'', December edition.

Norsk Sokkel, Oljedirektoratet, Interview with Sigmund Stokka 2015. ''Når gode fat blir dyre'', January 6.

NRK Rogaland, Interview with Sigmund Stokka 2014. ''Kostnadene på norsk sokkel'', October 9.

Nyheter fra Oljedirektoratet 2016. ''De nominerte til Beste stand på ONS 2016'', September.

OilField Technology Magazine, 2017. ''Advancements in Automation'', February, page 29-30.

Pan European Networks: Science & Technology, Issue 12 2014. ''Profile: The DrillWell Centre'', September.

SPE Web Events, Webinar, 2017. ''Estimation of Risk Level Embedded in Drilling Operation Plans'', June 15.

Stavanger Aftenblad 2011. ''Stavangers første prestisjesenter'', September
Stavanger Aftenblad 2013. ''7000 milliarder kroner mer til Norge med bedre teknologi'', October.

Stavanger Aftenblad, Interview with Kristin Flornes 2015. ''Alt er ikke svart – lavere oljepris og omstilling gir også muligheter''.
Teknisk Ukeblad 2010. ''Boresenter vil øke sikkerheten'', December.

Teknisk Ukeblad, Interview with Harald Linga and Sigmund Stokka. ''Et «kick» i brønnen kan bli katastrofe. Nå tror norske forskere de har funnet en løsning'', November 2015.

Teknisk Ukeblad, Interview with Kristin Flornes 2015. ''Oppsagt oljeingeniør med god ide? Dette bør du satse på. Eksperttips fra bransjen''.

Upstream Online 2016. ''Slender advantage in well tech'', February 19.

DrillWell

DRILLING AND WELL CENTRE
FOR IMPROVED RECOVERY

Drilling and Well Centre for Improved Recovery

VISION

Unlock petroleum resources through better drilling and well technology.

OBJECTIVE

Improve drilling and well technology providing improved safety for people and the environment and value creation through better resource development, improved efficiency in operations and reduced cost.

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