DrillWell

DRILLING AND WELL CENTRE
FOR IMPROVED RECOVERY

DRILLWELL
FINAL
REPORT

NORCE   SINTEF   Universitetet i Stavanger   NTNU   sfi Centre for Research-based Innovation

The Research Council of Norway

Foreword
– By Centre Director

We herein summarize the ambitions, efforts and main results from the DrillWell centre activities. DrillWell (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 and has been financed by the Research Council and the industry for an eight-year period. A primary goal has been to reduce drilling and well cost on the Norwegian Continental Shelf whilst supporting a safe work environment. The industry partners have prioritized and directed the research efforts towards particular challenges. DrillWell is an industry-driven collaboration and innovation environment.

This report includes a summary of who has been involved, how the centre was organised and financed, key results, the research organisation, benefits for the partners and the society, and future prospects.

Detailed information is included in the annual reports and the publications (listed in the appendix).

Sigmund Stokka
DrillWell Manager, NORCE

DrillWell

DRILLING AND WELL CENTRE
FOR IMPROVED RECOVERY

Foreword
– By Executive Vice President - NORCE Energy

When DrillWell was established in 2011, only a few people talked about digitalization in the oil and gas industry. Moreover, most people did not worry about the costs of plugging wells or about CO2 emissions from drilling operations. However, the importance of improved recovery was emphasized both by the oil and gas industry and the government - drilling more wells and increasing the efficiency of drilling were stated to be the most important factors for improving oil recovery.

At the start-up of the centre, researchers from IRIS (now NORCE), SINTEF, NTNU and UiS had already worked for more than two decades with digitalization technologies for the oil & gas industry. They established research infrastructures for automated drilling and innovative solutions for well integrity. It was evident that these four institutions had the necessary competence, infrastructure, and industry relations to create a Centre for Research-based Innovation.

Since the centre establishment in 2011, the focus areas of DrillWell have gradually become key priority areas also for the industry. In the last few years, operators have made huge investments in data handling and distribution centres, and the number of SMBs (Small and medium sized companies) developing digitalization solutions for the industry is growing. Digitalization and automation are now well-established focus areas in the industry, while plugging and abandonment has also gained more attention. The DrillWell partners are recognized as world-leading research institutions within these fields. This position has been strengthened during the eight years of the centre activities thanks to long-term financing and the close cooperation with the industry partners.

At the end of DrillWell, we can proudly say that the centre has made a difference by contributing to one of the greatest success stories of research-based innovation in Norway. Sekal was established in 2011 on the basis of research performed at IRIS. Thanks to the research in DrillWell and support from industry partners in the centre, the technology became world leading of its kind and has been proven to reduce drilling costs in the order of several billion NOK. Furthermore, the related reduced emissions are in the order of 100s of kilotons. This would not have been possible without DrillWell.

DrillWell has had a very positive effect on industry's recognition of research-based innovation. The centre is now seen as complementary to industry-driven developments from the service companies. The sharing of knowledge and the collaboration in these centres are essential to bringing the industry forward, from educating tomorrow's engineers and researchers to creating innovation that makes a difference.

NORCE would like to thank the Research Council of Norway for awarding us this centre and for their cooperation and financial support. We would also like to thank our industry partners Equinor, ConocoPhillips, Wintershall and AkerBP for prioritizing the centre, for cooperating on research, and for challenging us. Finally, I would like to thank our research partners UiS, SINTEF and NTNU for a long and fruitful cooperation.

Aina Berg
Executive Vice President – NORCE Energy

CONTENT

Summary

With a vision to unlock petroleum resources through better drilling and well technology, DrillWell has contributed with new knowledge and technology. The main objective has been to improve drilling and well technology, provide improved safety for people and the environment and value creation through better resource development, improved efficiency in operations and reduced cost.

A substantial contribution has been made to cost reductions achieved during the period 2014-19, which were in the range of 30-50%.

The consortium consisted of the research partners NORCE, SINTEF, NTNU – Norwegian University of Science and Technology and University of Stavanger and the industry partners AkerBP, ConocoPhillips, Equinor and Wintershall DEA.

The scientific results have been documented in more than one hundred journal papers and several hundred papers presented at international conferences, mainly within the areas of drilling process optimisation, well control, well integrity and plugging and abandonment (P&A) of wells.

Highlights of scientific results cover

- Development and application of a transient model for estimating the distribution of drilling cuttings in the well and the transport to surface

- Development and application of a transient drill-string torque and drag model

- Development and application of models for drill-string torsional and axial vibrations

- Development and application of a model for reconstructing drill-string movement

- Measurements of gas solubility in drilling fluid base oil which is important for well control while drilling high-pressure and high-temperature wells

- Full scale well cementing experiments showing the potential for leaving the pipe in hole when plugging and abandoning wells

- Testing of well barrier verification tools

The results have been utilised by the participating oil companies and their service providers, improving services and proving new technology. Our focus on the drilling process optimisation and plugging and abandonment of wells has in particular assisted the industry with valuable tools and knowledge for planning and executing drilling and well operations, for automated drilling control as well as cost efficient plugging and abandonment of wells.

According to The Norwegian Petroleum Directorate (Oljedirektoratet) the frequency of technical sidetracks was greater than 30 percent in the period from 2013-2016. Applying technology developed in DrillWell has so far reduced this frequency to 9 percent. One of the operators using this technology reports potential savings of 180 million USD annually. In 2017 Equinor implemented automated drilling on rigs and reported savings of approximately 100 million NOK for two well sections in the Barents Sea. Technology developed in the Drilling Process Optimisation project was important in order to enable drilling automation on rigs. Equinor and Wintershall

DEA are now deploying the technology on seven rigs in collaboration with Sekal and NORCE.

13 PhD students have contributed to the research activities (all 7 Phase 1 students have defended their thesis and the rest are in the completion phase) together with 109 master students.

There has been a fruitful cooperation with five universities in the USA, two in Canada, two in France and one in the Netherlands. They have contributed substantially within topics such as drilling mechanics, geo-steering and well integrity. This has resulted in 42 peer reviewed papers with international co-authors, one patent together with a foreign university, permanent recruitment of excellent guest researchers at the host institution and several joint projects and applications.

The research partners have established plugging and abandonment of wells as a strong new research area and have also expanded the research fields of drilling process optimisation, well control and well integrity.

Organising the research activities in a centre has enabled long term knowledge building, technology development and the establishment of dedicated laboratory and test facilities.

DrillWell has become a recognized brand name within drilling and well research and technology development both in Norway and abroad. It has benefitted the research partners in establishing additional research projects as well as the commercialization of research results. The DrillWell partners are promoting further research and innovation within the centre's areas of strength; drilling process optimisation, well control, well integrity and plugging and abandonment of wells.

Research activities with drilling process optimisation, drilling automation, well control, geo-steering and well plugging and abandonment of wells are continuing in established spin-off projects. After the first development and patenting of a geopolymer plugging material in DrillWell the company SafeRock was established and the technology is being further developed with support from oil companies. A national infrastructure is also being developed for plugging and abandonment of wells in a cooperation between the DrillWell research partners, which will be available to academia and industry working to develop new knowledge, technology and methods to secure abandoned wells avoiding leakage and to reduce abandonment costs.

There is a dialogue with the DrillWell industry partners on a model for DrillWell after the SFI that is expected to be concluded early in 2020.

NORSK SAMMENDRAG

Med visjonen å utvinne ekstra petroleumsressurser gjennom bedre bore- og brønnteknologi har DrillWell bidratt med kunnskap og teknologi. Hovedmålsetningen har vært å forbedre bore- og brønnteknologi, øke sikkerheten for mennesker og utstyr, forbedre effektiviteten i operasjoner og redusere kostnadene. Et vesentlig bidrag har blitt gitt til kostnadsreduksjoner som er oppnådd i perioden 2014-19, som er på 30-50 %.

Konsortiet har bestått av forskningspartnerne NORCE, SINTEF, Norges teknisk-naturvitenskapelige universitet og Universitetet i Stavanger og industripartnerne AkerBP, ConocoPhillips, Equinor og Wintershall DEA.

De vitenskapelige resultatene er dokumentert i mer enn hundre journal-artikler og flere hundre artikler som er presentert ved internasjonale konferanser, hovedsakelig innen områdene optimalisering av boreoperasjonen, brønnkontroll, brønnintegritet og plugging og forlating av brønner (P&A).

Høydepunkter av vitenskapelige resultater dekker

- Utvikling og anvendelse av en transient modell for estimering av fordelingen av borekaks i en brønn og transport av borekaksen til overflaten

- Utvikling og anvendelse av en transient model for beregning av borestrengens dreiemoment og glidefriksjon

- Utvikling og anvendelse av en modell for borestrengens torsjonelle og aksielle bevegelse

- Utvikling og anvendelse av en modell for rekonstruksjon av borestrengens bevegelse

- Måling av gass-løselighet i oljebasert borevæske, som er viktig for brønnkontroll ved boring av brønner med høyt trykk og høy temperatur

- Fullskala sementeringseksperimenter, som viser potensialet for å etterlate rør i brønner som plugges og forlates

- Testing av verktøy for verifisering av brønnbarrierer

Resultatene har blitt brukt av de deltakende oljeselskapene og deres serviceselskap, som har forbedret sine tjenester og kvalifisert ny teknologi. Vårt fokus på optimalisering av boreprosessen og plugging og forlating av brønner har i særlig grad assistert industrien med verdifulle verktøy og kunnskap for planlegging og utførelse av bore- og brønnoperasjoner, for automatisert boring samt kostnadseffektiv plugging og forlating av brønner.

Ifølge Oljedirektoratet var andelen av uønskede tekniske sidesteg større enn 30 % i perioden 2013-2016. Ved bruk av teknologi utviklet i DrillWell, har denne andelen så langt blitt redusert til 9 prosent. Besparelsene for operatørene er i størrelsesorden flere milliarder kroner i dette tidsrommet. En av operatørene som bruker denne teknologien i et automatisert styringssystem på boreriggen, rapporterer potensielle besparelser på anslagsvis 100 millioner kroner for to brønnseksjoner i Barentshavet. Teknologi utviklet i prosjektet for optimalisering av boreprosessen, var avgjørende for å kvalifisere boreautomatisering på flytende borerigger. Equinor og Wintershall DEA anvender nå denne teknologien på sju rigger i samarbeid med Sekal og NORCE.

13 PhD-studenter har bidratt til forskningsaktivitetene (alle de 7 studentene i Fase 1 har forsvart sin avhandling og de resterende er i avslutningsfasen) sammen med 109 master-studenter.

Der har vært et fruktbart samarbeid med fem universiteter i USA, to i Canada, to i Frankrike og ett i Nederland. Dette har gitt et betydelig bidrag innen tema som boremekanikk, geo-styring og brønnintegritet. Samarbeidet har resultert i 42 fagfellevurderte artikler med internasjonale medforfattere, en patent sammen med et utenlandsk universitet, permanent rekruttering av dyktige gjesteforskere ved vertsinstitusjonen og flere fellesprosjekter og prosjektsøknader.

Forskningspartnerne har etablert plugging og forlating av brønner som et sterkt nytt forskningsområde og har utvidet forskningsområdene optimalisering av boreprosessen, brønnkontroll og brønnintegritet.

Å organisere forskningsaktivitetene i et senter har muliggjort langsiktig kompetansebygging, teknologiutvikling og etablering av dedikerte laboratorier og testfasiliteter.

DrillWell har blitt et anerkjent merkenavn innen bore- og brønnforskning og teknologiutvikling både i Norge og utenfor landets grenser. Senteret har kommet forskningspartnerne til nytte ved å etablere nye forskningsprosjekter samt ved å kommersialisere resultater. Partnerne i DrillWell promoterer videre forskning og innovasjon innen senterets sterke områder; optimalisering av boreprosessen, brønnkontroll, brønnintegritet og plugging og forlating av brønner.

Forskningsaktiviteter innen optimalisering av boreprosessen, automatisert boring, brønnkontroll, geo-styring og plugging og forlating av brønner fortsetter i etablerte og nye prosjekter. Etter den første utviklingen og patenteringen av et geopolymer pluggemateriale i DrillWell ble selskapet SafeRock etablert, og teknologien videreutvikles med støtte fra oljeselskaper. Det utvikles også en nasjonal infrastruktur for plugging og forlating av brønner i et samarbeid mellom DrillWells forskningspartnere, som vil være tilgjengelig for akademia og industri som jobber for å utvikle ny kunnskap, teknologi og metoder for å sikre forlatte brønner, unngå lekkasjer og redusere pluggekostnadene.

Det er en dialog med DrillWells industripartnere om en modell for DrillWell etter SFI, som forventes konkludert tidlig i 2020.

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 close to 50 % of the field development cost.

SUMMARY OF ACHIEVMENTS

DrillWell has delivered a substantial contribution to the drilling and well cost reductions that the industry has achieved during the period 2014-19, which were in the range of 30-50%. Our focus on drilling process optimisation and plugging and abandonment of wells has in particular assisted the industry by providing valuable tools and knowledge for planning and executing drilling and well operations, for automated drilling control as well as cost efficient plugging and abandonment of wells. Results from DrillWell have been implemented as key elements in software that has been proven to reduce the number of technical sidetracks during drilling operations from a previous level of more than 30% on average to below 10%. The reduced cost realized through this improvement alone is in the order of 3-5 billion NOK and the reduced carbon footprint is more than 100 kilotons of CO_2.

The contribution to academia is more than 100 peer reviewed papers and the education of more than 100 master and PhD students, most of whom have stayed in the industry or academia and are now contributing to improved oil recovery.
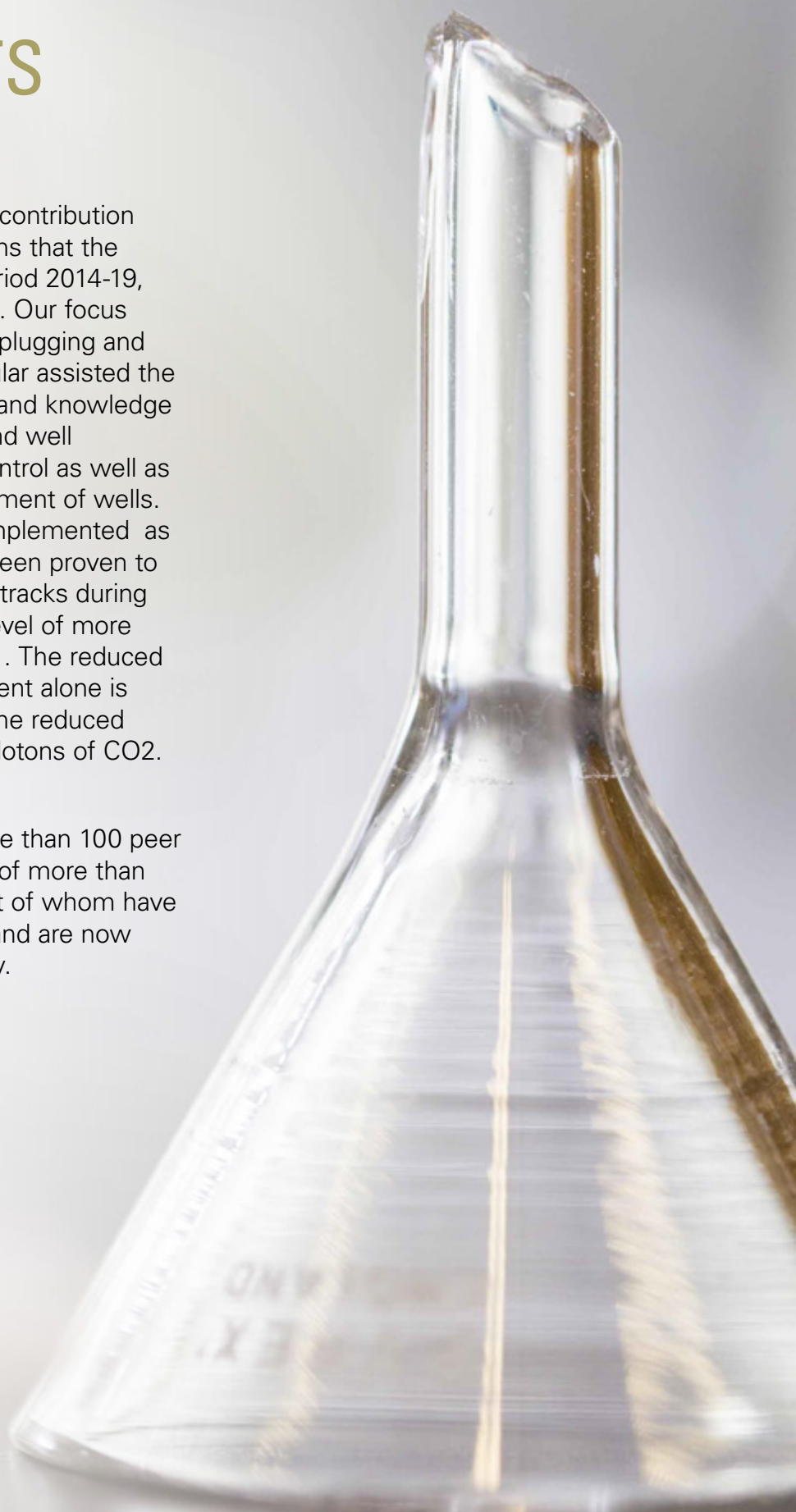
RESEARCH PARTNERS

The following research partners have been active during the whole SFI period 2011-2019:

NORCE NORWEGIAN RESEARCH CENTRE (HOST)

SINTEF INDUSTRY

NTNU

UNIVERSITY OF STAVANGER

INDUSTRY PARTNERS

The following oil companies have been active in the Centre:

2011-19

2011-19

2011-19

2012-14

2015-16

2011-14

2011-19

DRILLWELL ORGANISATION

DrillWell Board

Technical Committee

Scientific Advisory Committee

Centre Manager & Management Group

PROGRAMME 1

Safe and Efficient Drilling Operations for Cost Reduction

PROGRAMME 2

Geosteering and Drilling Solutions for Improved Recovery

PROGRAMME 3

Well Solutions for Improved Recovery

Reference group P1

Completed in 2016

Reference group P3

SCIENTIFIC ADVISORY COMMITTEE

Members of the Scientific Advisory Committee have been Kitt Anita Ravnkilde, Principle Programme Manager at Danish Hydrocarbon Research & Technology Centre, DTU, John Thorogood, Drilling Engineering Advisor at Drilling Global Consultant LLP and Andrew K. Wojtanowicz, Texaco Environmental Chair and Professor in Craft and Hawkins Petroleum Engineering Department at Louisiana State University.

SENIOR/KEY RESEARCHERS

The following senior/key researchers have contributed substantially to the centre results:

Dave Gardner, *NORCE*
Jostein Sørbø, *NORCE*
Jan Einar Gravdal, *NORCE*
Johnny Petersen, *NORCE*
Eric Cayeux, *NORCE*
Benoit Daireaux, *NORCE*
Hans Joakim Skadsem, *NORCE*
Eric Patrick Ford, *NORCE*
Helga Gjeraldstveit, *NORCE*

Øystein Arild, *UiS*
Kjell Kåre Fjelde, *UiS*
Helge Hodne, *UiS*

Knut Steinar Bjørkevoll, *SINTEF*
Idar Larsen, *SINTEF*
Nils Opedal, *SINTEF*
Ragnhild Skorpa, *SINTEF*
Torbjørn Vrålstad, *SINTEF*
Harald Linga, *SINTEF*
Ane Lothe, *SINTEF*
Jan David Ytrehus, *SINTEF*

Sigbjørn Sangesland, *NTNU*
Sigve Hovda, *NTNU*

Eric Cayeux
NORCE

Jan Einar Gravdal
NORCE

Helga Gjeraldstveit
NORCE

Harald Linga
SINTEF

Knut Steinar
Bjørkevoll
SINTEF

Torbjørn Vrålstad
SINTEF

Ragnhild Skorpa
SINTEF

Hans Joakim
Skadsem
NORCE

Dave Gardner
NORCE

Prof. Kjell Kåre Fjelde
UiS

Prof. Sigbjørn
Sangesland
NTNU

COOPERATION

During the centre's initial period, key researchers were gathered for a planning and knowledge exchange to enhance the cohesiveness of the centre. Frequent management meetings have been arranged with the participation of all Research Partners. Discussions with the Industry Partners have been held in the Board, the Technical Committee and the Reference Groups. Annual seminars have given room for an interaction with relevant users of the centre results, including oil companies and service suppliers.

Financing

FINANCIAL SUMMARY

Contributor	Cash	In-kind	Total
Host		4	
Research partners		14	
Companies	132		
RCN	80		
Sum	**212**	**18**	**230**

Numbers in NOK million.

DISTRIBUTION OF RESOURCES

Type of activity	Numbers in NOK million.
Research projects	200
Common centre activities	8
Administration	22
Total	230

Three Petromaks2 projects have been associated with the centre. The financing and cost of the Petromaks2 projects and additional funding from the DrillWell Partners are not included in the numbers above. The total funding including additional funding from the DrillWell partners and The Research Council of Norway (Petromaks2) was 345 NOK million.

Results – Key figures

THE CENTRE RESULTS ARE SUMMARIZED IN THE TABLE BELOW.

	Total
Scientific publications (peer reviewed)	104
Dissemination measures for users	365
Dissemination measures for the general public	27
PhD degrees completed	7
Master degrees	109
Number of new/improved methods/models/prototypes finalised	5
Number of new/improved products/processes/services finalised	8
Patents registered	5
New business activity	2
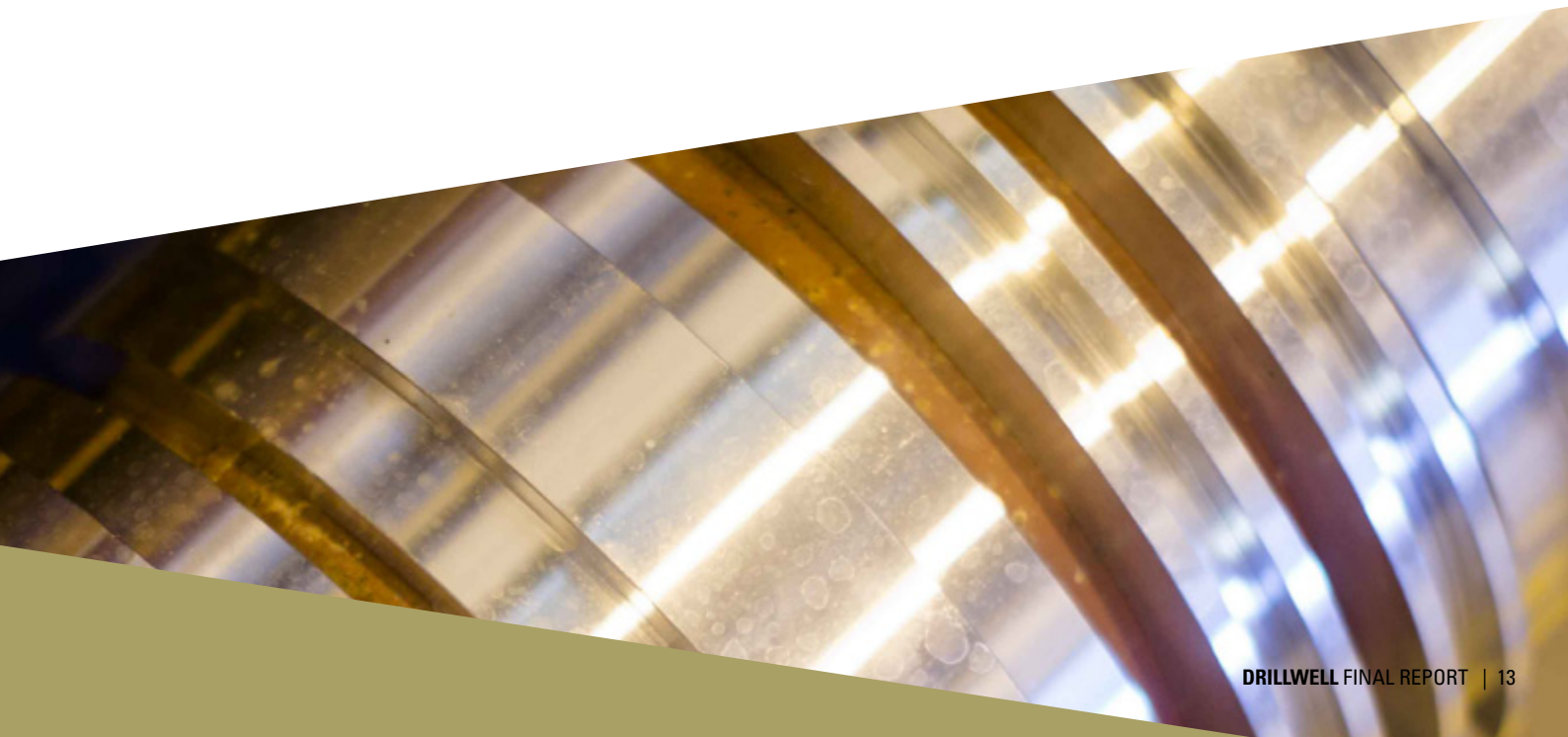
# Original research plan and development of research plan

The initial research plan had a broad scope of work which was in line with the ambitions of the sponsoring oil companies to improve many segments of current drilling and well technology. Research activities were organised in three programmes:

- Programme 1: Safe and efficient drilling operations for cost reduction
- Programme 2: Geo-steering and drilling solutions for improved recovery
- Programme 3: Well solutions for improved recovery

During the mid-term evaluation it was suggested to focus the scope and reduce the number of projects. In the second phase of operation the centre has therefore prioritized larger projects that would enable more industry-oriented research and innovation. It was decided to concentrate on these areas:

- Drilling process optimisation (Programme 1)
- Well control (Programme 1)
- Well integrity (Programme 3)
- Plugging and abandonment of wells (Programme 3)

A part of the industry funding was used to fund three spin-off Petromaks2 projects jointly with the Research Council, that expanded the scope of work within the same research areas.
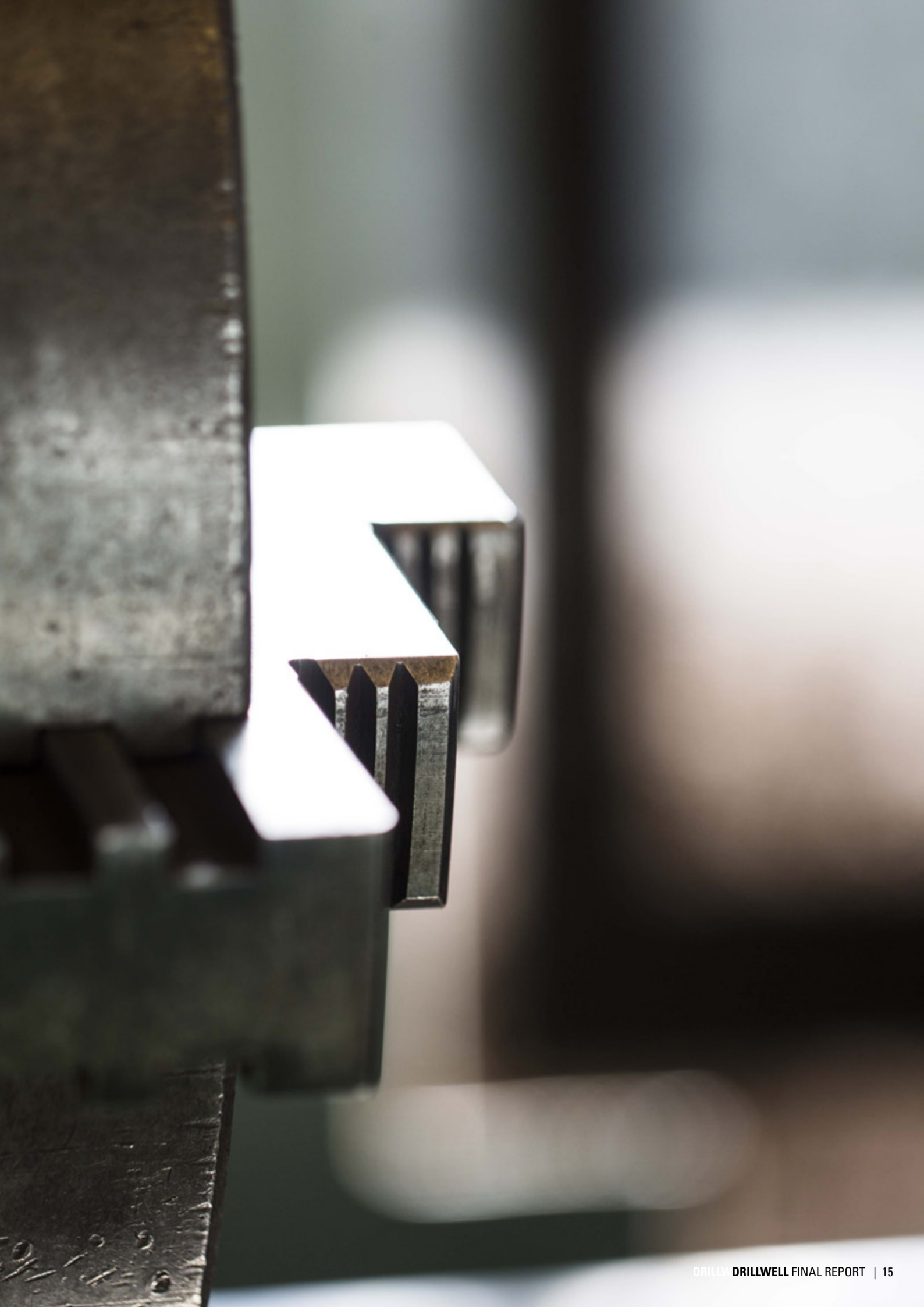
RESEARCH ACHIEVEMENTS

DrillWell's Programme 1 on safe and efficient drilling operations for cost reduction has addressed sensors, distribution of drilling data and interoperability, data analysis, drilling control systems as well as fundamental research such as on drilling fluid properties.

Drilling process optimisation

The activity on drilling process optimisation has produced ground-breaking research with a direct impact on drilling efficiency in the field and which has moved the research front within several areas.

One example is the new transient cuttings transport model which simulates the transport of drilled cuttings from the bottom of the well to surface. Predictions of cuttings accumulation and settling can now be performed with improved accuracy at high computational speed, and the model is therefore applicable both during the execution of the drilling operation and for optimisation purposes. Sufficient transport of cuttings is a key element during drilling operations and is influenced by many factors. A better understanding of this process and accurate and reliable predictions has been a major limitation for optimising drilling parameters, particularly in inclined wells and wells with a narrow pressure margin. This model is one of several DrillWell developments that has been implemented in Sekal's software for the planning and execution of drilling operations.

In addition, a transient mechanical model has been developed for simulating the axial and torsional movement of the drill-string, combined with advanced transient hydraulic calculations of the entire mud flow line. As a result, a fully coupled high fidelity hydro-mechanical, heat transfer and solid transport model has been developed in DrillWell. The combined model accounts for hydraulically induced forces on the drill string, mechanical friction, the physics of the hoisting and top-drive system and bit-rock interactions, as well as the multiphase flow behaviour of the drilling fluid with cuttings.

The above-mentioned models have been integrated in existing software supplied by Sekal (DrillScene® and DrillTronics®) and have also resulted in new software products (DrillExpect®). The transient cuttings transport model has been one of the key reasons that DrillScene has contributed to the reduction in the number of technical sidetracks from a frequency of more than 30% on average to less than 10% in operations where it has been used. This is a major contribution to reduced drilling costs and emissions from the drilling process. Statistics show that as many as 40 technical sidetracks have been avoided in operations where DrillScene is used compared to other drilling operations on

the Norwegian Continental Shelf. This is equivalent to a cost saving in the order of 3-5 billions NOK and reduced CO_2 emissions in the order of 100 kilotons.

The models have also been key elements to enable drilling automation on floating rigs. The development of the transient torque & drag model was a technological breakthrough and one of the reasons that Sekal was awarded a contract to install DrillTronics on five Transocean harsh environment semi-submersible drilling rigs plus the West Mira rig. As a result of the technological improvements in Sekal's products and an increasing number of contracts, Sekal was acquired by Sumitomo in July 2019.

In addition to the implementation in Sekal's products, these models have also been made available in an openly available infrastructure for education, research and innovation called; OpenLab Drilling. The development of OpenLab started in 2015 and offers a web enabled drilling simulator as well as Hardware-in-the-loop (HIL) environment for the development and testing of new software for drilling automation.

In addition to innovations that have found their way to commercial products, several prototype technologies have been developed with great potential for commercialisation. One example is a software that uses a quantitative risk evaluation methodology to estimate the risk when utilizing a specific drilling operation plan. By varying the drilling parameters and propagating the uncertainty in the operational scenario (geopressure margins, survey, drilling fluid properties) various scenarios can be investigated, and the operational plan optimised with a quantified uncertainty. Another example is the pipe movement reconstruction software that calculates the true drill-string movement based on a set of downhole sensors. A prototype has been developed and testing is being performed in 2019 together with commercial vendors of downhole sensors. A third example is a software for calculating the weight of the drill string (hook load), which is important for controlling the correct weight applied to the drill-bit. The software uses data from the drilling control system that is normally taken from a sensor in the deadline or at the top drive and takes into account the friction in the hoisting system and other forces having a significant impact.

Further, the impact of solid content on the apparent rheological behaviour of drilling fluids has been analysed and quantified. This is important for improving the accuracy of pressure loss estimations while transporting cuttings but also to model the pressure evolution during pack-off situations. The time dependence of the rheological behaviour of drilling fluids has also been studied. Drilling fluids have a complex thixotropic behaviour that could not be reproduced accurately by currently published models. A new model has been derived that can be used to improve the estimation of pressure losses during stick-slip conditions. When the drill-string rotational speed alternates between no rotation and very high levels, the thixotropic behaviour of drilling fluids needs to be accounted for in order to better estimate pressure losses in the annulus.

Within data acquisition and interoperability, the activity on the drilling data hub (DDHub) has been important. DDHub is a prototype drilling data aggregation system where the development started in DrillWell as a necessary tool to streamline the installation and operation of automated drilling systems. The challenge of many different data formats and interfaces is a major bottleneck for drilling automation.

It causes unnecessary installation costs and may limit the performance of existing and new systems, alone and combined. The technical development of the semantics and the dialogue with stake holders and standardization organisations has continued in a separate Demo2000 project since 2017.

The drilling process optimisation project has included two post docs, one PhD and educated several master students. In one of the post docs, Ulf Jacob Flø Aarnes has studied many aspects of the dynamic behaviour of drill-strings. Drill string vibrations and their negative consequences on rate of penetration and equipment is a well-known phenomenon when drilling and the torsional oscillations known as stick-slip in particular. The analysis of drill sting vibrations was extended to include vibrations caused by bit-rock interaction and drillstring-wellbore interaction. In another post doc, Jing Zhou has worked on control algorithms for Managed Pressure Drilling, in particular for well control applications. In her PhD, Solveig Riisøen has studied the accuracy of modelling friction pressure loss while circulating drilling fluids in a well, based on a rheological characterisation of the drilling fluid.
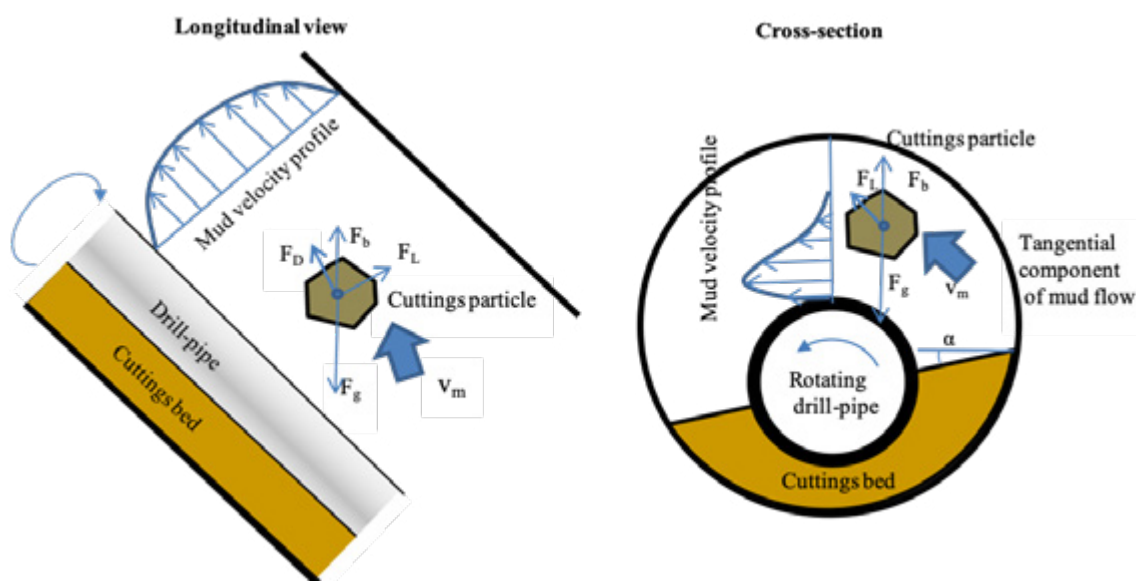

Force acting on a cuttings particle in suspension. From SPE 163492 "Real-Time Evaluation of Hole Cleaning Conditions Using a Transient Cuttings Transport Model" by Eric Cayeux et al., presented at the SPE/IADC Drilling Conference and Exhibition held in Amsterdam, The Netherlands, 5–7 March 2013.

Well control

Activities related to well control have given new and improved insight into phenomena that are important for kick detection and well control operations. First experimental studies of oil-gas interaction, subsequent modelling and simulations to replicate experimental findings, and combined simulation studies and analysis of field data have been performed in cooperation with drilling engineers.

The presence of formation gas in drilling mud, either dissolved or entrained, represents a potential risk toward safe well operations and the avoidance of severe gas kicks. For drilling high pressure and high temperature wells, oil-based drilling fluids are preferable to water-based due to their beneficial properties related to lubrication, shale stability and high pressure – high temperature tolerance. On the other hand, oil-based drilling fluids have a significantly higher capacity for physically absorbing natural gas compared to water-based drilling fluids. This makes the topside detection of bottom hole gas influx into oil-based drilling fluids more difficult during stationary operations such as flow checks or during continuous operation when circulating the drilling fluid towards the topside.

The experimental campaigns studied gas solubility in representative drilling fluids as a function of temperature and pressure up to extreme conditions. Two different base-oils showed very different behaviour when entering the dense-phase region above 400 to 500 bar, which may be important knowledge for the determination of which fluid is optimal for a given drilling operation. Compositional PVT (pressure-volume-temperature) models, including PVTsim and an internal SINTEF code, were used for the actual base-oil compositions to reproduce results. This work showed that a reasonably good match was obtained after calibrating internal parameters in the PVT code. Accordingly, a procedure for fluid-specific calibration of PVT calculations based on laboratory measurements was suggested. For practical use automating some of the steps is considered feasible and recommended. Response of dissolved gas on rheology was measured.
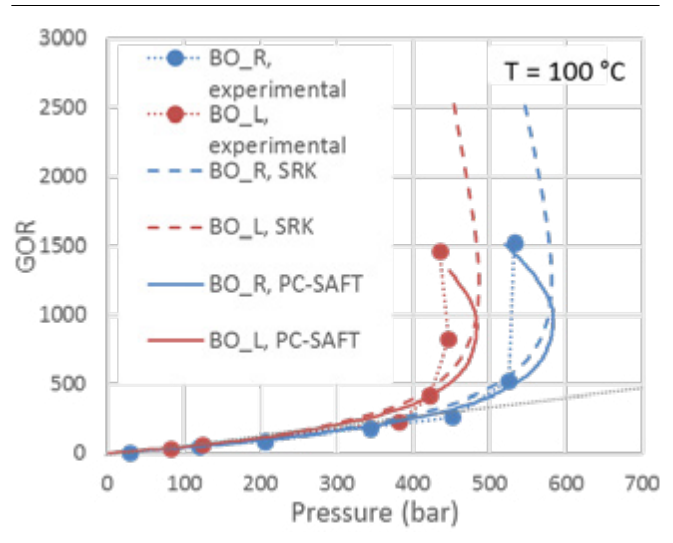
Gas loading capacity for refined mineral oil (BO_R) and linear paraffin (BO_L); experimental and calculations based on the two equations of state Soave-Redlich-Kwong (SRK) and perturbed chain statistical associating fluid theory (PC-SAFT). GOR is gas oil volume ratio with volumes converted to standard conditions. The black dotted line corresponds to Henry's law.
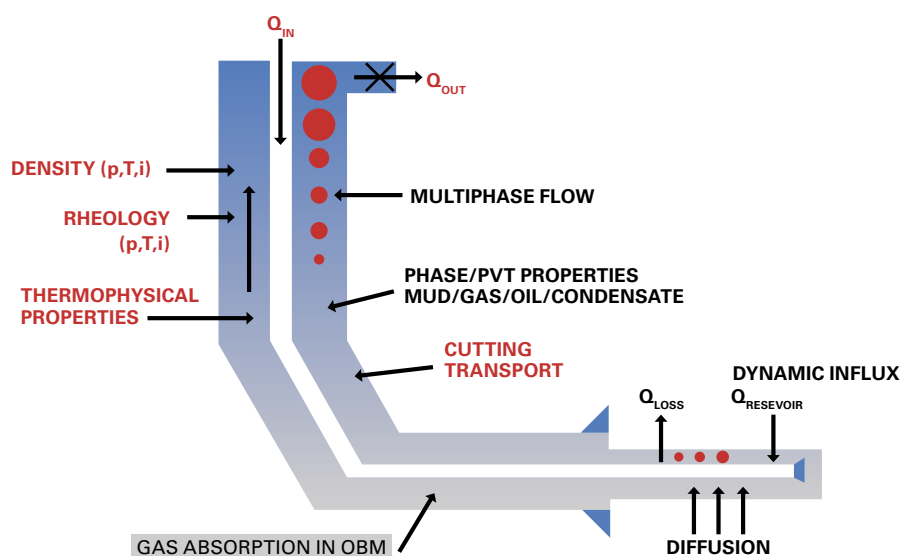
Gas absorption in oil-based mud and identification of key parameters potentially affected.

The time dependence of oil-gas interactions with and without rotation was studied in an experimental setup that was designed in DrillWell.

A well control simulator prototype has been developed and includes new sub-models for compositional PVT calculations for dense fluid phase, including time-dependent gas absorption and degassing. Understanding the interaction between hydrocarbons from the reservoir and drilling fluids is a key concern for safer drilling operations.

Two field cases were studied in detail by first analysing the field data thoroughly with help from drilling engineers and then running simulations with the well control simulator while adjusting input parameters to get a good fit with measurements. The result was invaluable operational knowledge for researchers and published analyses that share findings related to kick characterization and well control

physics. The work done is considered a good basis for both continued cooperation between researchers and operations, and for building improved automated software tools for real-time decision support.

Two PhDs have been educated in this project. Dalila de Sousa Gomes has worked on gas kick simulation including gas dissolution in drilling mud and gas migration along the well from downhole to surface in risers at ultra-deep waters. Stochastic modelling was implemented to incorporate uncertainty and give a better overview of the process. Marius Staahl Nilsen has studied 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 drilling fluid during a gas kick and then suddenly boil out of the liquid as the drilling fluid is pumped towards the surface. An apparatus was built to measure how fast gas is liberated from an oversaturated liquid.

PRESSURE AHEAD

The knowledge-building project PressureAhead introduced new methods to reduce the uncertainties in geo-pressure prediction ahead of the bit. Wrong assumptions regarding pressure and mud weight during drilling, may lead to non-productive time due to mud loss, stuck pipe and well control incidents.

Since the input data is uncertain and our understanding of the processes are 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.

The new fast 3D pressure simulator has been tested on a dataset from Alvheim, North Sea. Sensitivity on the input data for pore pressure and mud weight window prediction have been 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 at the Norwegian Continental Shelf.

A new method for conducting sensitivity analysis over the uncertainties involved in the mud weight window assessment was developed by PhD student Jacopo Paglia. The most important input parameters for the mud density were investigated. Next, the output from this sensitivity analysis was used to evaluate how the assimilation of new data can improve our knowledge about the appropriate mud density. This was done with the aid of value of information analysis, coupling the uncertain variables with drilling decisions in a tradeoff between costs and risks.

A case study from an offshore field in the North Sea was investigated, with focus on a shale layer with potential drilling risk. The most important uncertainties in this case were found to be pore pressure, rock strength and horizontal stress. The value of information analysis indicated that data about the rock's compressive strength was the most valuable in this case.
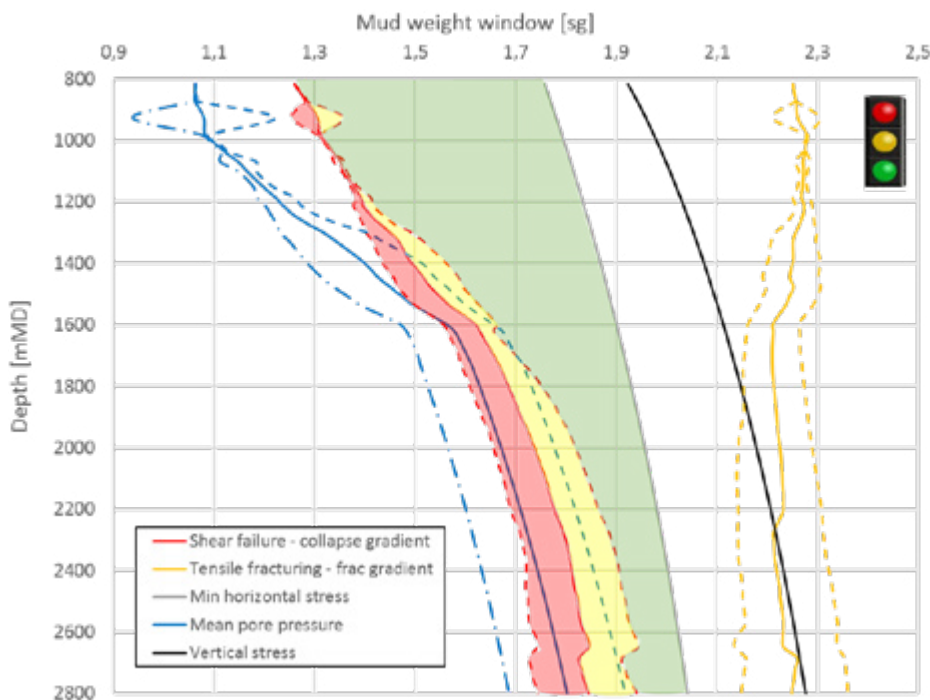
Traffic light showing a safe drilling window using the collapse gradient and the minimum horizontal stress as guide lines. Blue graph shows mean pore pressure gradient, with minimum pressure gradient (stippled line), and maximum gradient (stippled and dotted lines). Red graph shows collapse gradient 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. (2019, accepted SPE Journal).

Well integrity

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.

A scientific approach has been applied to study the integrity of well barrier materials used to secure the well integrity during a well's life cycle. For many wells the temperatures and pressures can change substantially as the well is producing oil and gas or is converted to a water injector. Ensuring well integrity is important to prolong well lifetime and to minimise leakage to the environment.

A unique laboratory set-up for determination of cement sheath integrity before and after pressure cycling has been designed and built. It was used in laboratory experiments aiming for an improved understanding of how to secure a high-quality barrier in offshore wells. X-ray computed tomography (CT) was used to obtain three-dimensional visualisation and quantification of the cement sheath integrity. A simulation tool was used to visualise and quantify fluid flow through real cracks and micro-annulus geometries.

In his PhD, Jesus Alberto de Andrade Correia addressed the potential breach of long term well integrity caused by temperature cycling in the wellbore. He developed a novel laboratory set-up to investigate deformations and fractures in a scaled down section of a wellbore. The deformation and failure in the cement sheath was characterized using detected acoustic emission events while running the experiments and inspecting the core between the temperature cycles using computer tomography.

Large-scale tests were run to investigate the process of displacing drilling and spacer fluids with cement in irregular wellbore geometries. The purpose of the experiments was to investigate how hole enlargement and inner-string eccentricity affects the cement placement in near horizontal annuli. A computational fluid dynamics model in OpenFOAM was developed for eccentric annuli with an area of extended diameter and was used for simulations related to the large-scale cement displacement tests. In many cases, three-dimensional simulations agreed well with the experiments. The hardened cement was investigated using pressure and leakage tests.

In his PhD, Shreyanisch Divyankar worked on visualising flow phenomena and studying the flow of non-Newtonian fluids in a lab-scale duct that represented an irregular well-bore geometry. The goal was to better quantify circulation efficiency during e.g. drilling fluid conditioning for primary cementing.

Important insights have been gained within cement integrity and placement, well barrier evaluation technology and acceptance criteria.
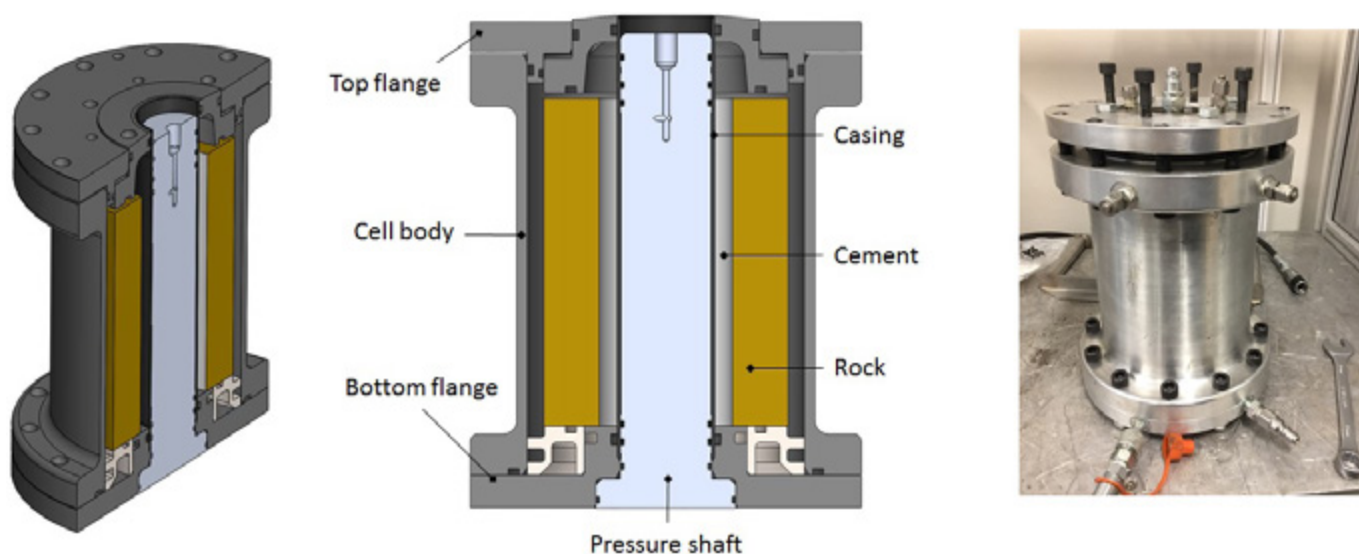
Schematic illustration and picture of experimental set-up for pressure cycling tests.

Visualization of fluid flow in cement sheath based on X-ray Computed Tomography (CT) images.
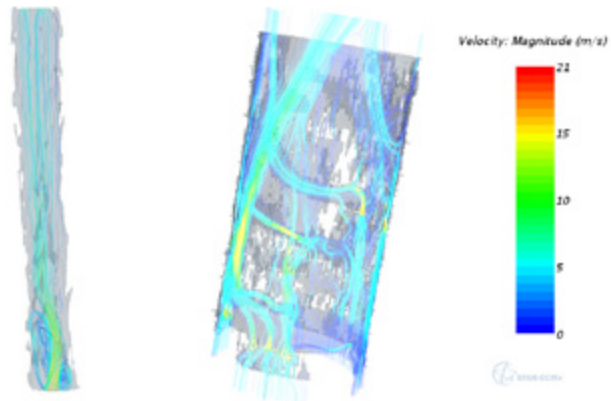
Fluid displacement loop at SINTEF used to study how cement is displacing the well fluid in irregular wellbore geometries.
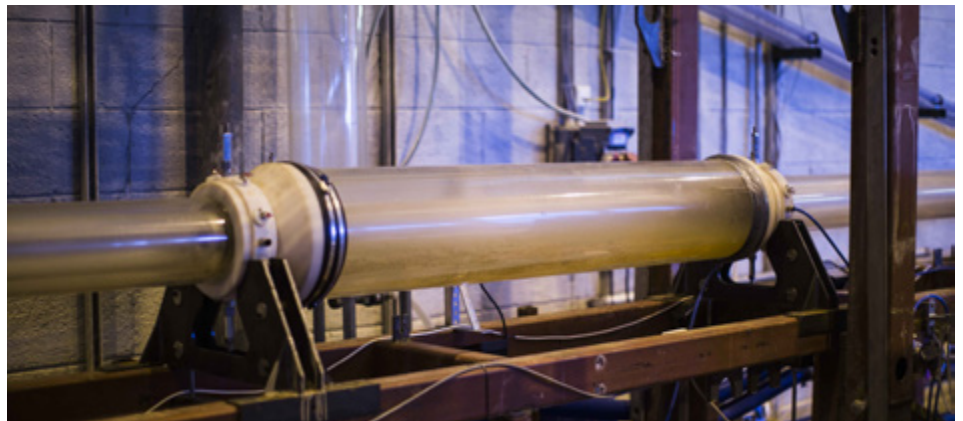
Four test assemblies at NORCE constructed with 7 inch tubing inside 9 5/8 inch casing and 16 inch washout section used to study cementing in irregular wellbore geometries.

The open source software OpenFOAM is used to study fluid displacement mechanics in the proximity of irregular wellbore sections.
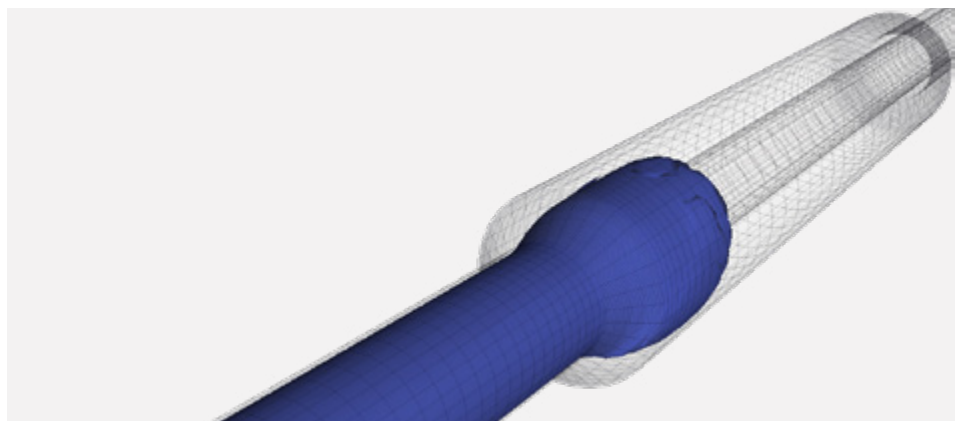
Plugging and abandonment of wells

In her PhD, Fatemeh Moeinikia looked into cost effective technologies for well plugging and abandonment and performed time and cost estimation for plugging and abandonment operations. She also considered how well design can be modified to allow for cost effective plugging and abandonment. She showed how cost efficiency can be improved by employing a combination of rig-based and rig-less technologies and reviewed the potential offered by utilizing light well intervention vessels for plugging and abandonment of subsea wells.

A systematic methodology for aging tests of well plugging materials at downhole conditions was developed and relevant long-term experiments were run.

A laboratory set-up for determining the sealing ability of cement/sealant plugs at selected conditions of pressure and temperature was built and used in testing. Gas flow around the plugs was measured for different pressure differentials. It was found that the surface roughness of the casing has a significant impact on the sealing ability of cement plugs.

In her PhD, Anisa Noor Corina worked on the integrity of cement placed inside a well casing for the abandonment phase. The project included experimental work using a small laboratory set-up that imitates the cement plug at realistic downhole conditions, flowing gas through the cement bulk.

Large-scale laboratory tests were run to demonstrate that it is possible to obtain good cement displacement when cementing with the tubing left in hole. Tests were run both with and without control lines attached to the tubing.

In his PhD, Mahmoud Khalifeh developed a new material of geopolymeric materials and investigated their usability for the plugging and abandonment and zonal isolation of wells. The produced materials are environmentally-friendly and they also have a potential to be use for civil engineering applications.

Full-scale test cells and blocks simulating well completions with a cemented annulus were designed and built and were used for the performance verification of cement logging tools and leakage detection tools and methods. Reference cells have also been built to represent well 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 measurement resolution of an acoustic listening platform logging tool has been investigated and it was concluded that the technology was able to detect flow generated noise at low water and gas flow rates. A range of test jigs mimicking multiple casing barrier configurations were used to verify the performance of a new logging technology prior to its employment offshore.

A software for risk-based planning and evaluation of plugging and abandonment of wells has been developed and will be an enabler for a methodology that can quantify the quality of a given plugging and abandonment solution. The risk-based approach being used has been applied to many other aspects of oil and gas exploration and production.
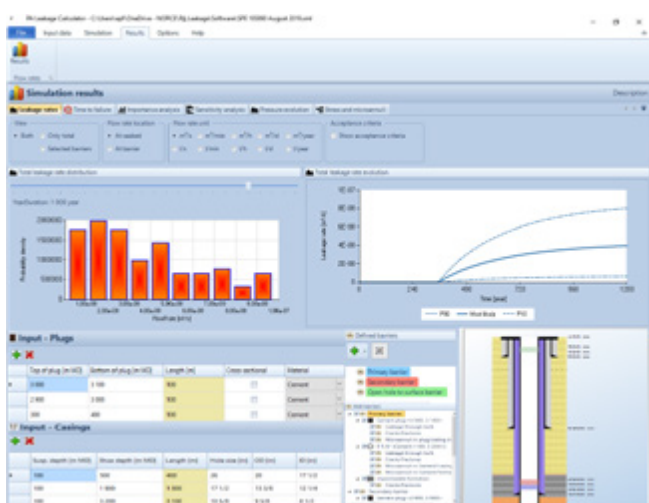
Picture of screen from Leakage Calculator developed for risk-based planning and evaluation of plugging and abandonment of wells.

Full scale tests to determine if a good seal can be obtained after plugging and abandonment with tubing left in hole.

Cut strings with 7 inches tubing cemented inside 9 5/8 inches casing with and without control lines.

Noise logging experiment using sound proofed cells installed in the Ullrigg HETE test pit.
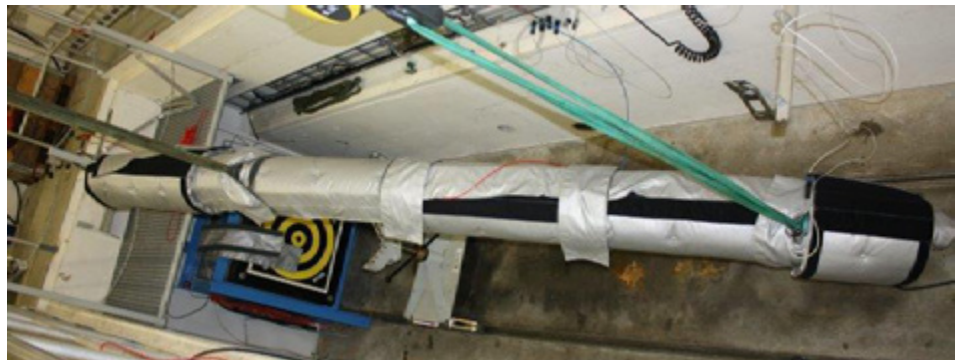
Barrier reference cells for performance verification of cement logging tools and leakage detection tools and methods.

GEO-STEERING

Phase 1 of DrillWell included a project on steering and optimising the well path while drilling by use of downhole sensors, advanced modelling and continuous updating of the earth model representing the geology. After Phase 1 the development was successfully continued in a Petromaks2 project.

In her PhD, Kanokwan Kullawan worked on improving the decision quality of geo-steering processes by introducing a decision analytics framework for geo-steering operations. Having a well-established decision process will enable better incorporation of a large amount of real-time data, experiences and expertise to achieve high quality decisions faster.

In his PhD, Erich Christian Suter developed novel principles for effective earth model grid management while geo-steering and a novel prototype software; Flexible Earth Model.

In her PhD, Yi Liu worked on utilising novel seismic methods for geo-steering.

Workflow proposed for geo-steering.
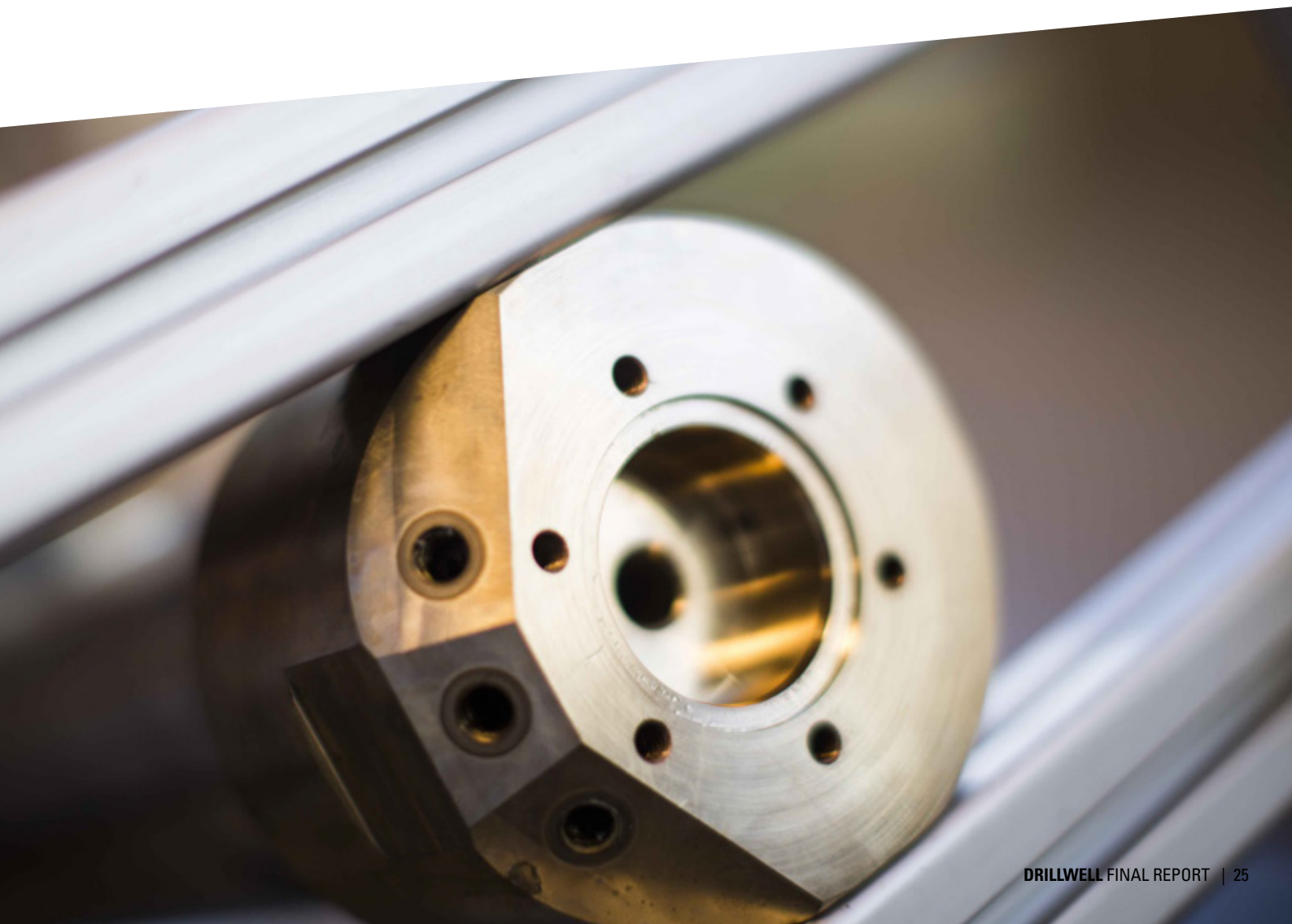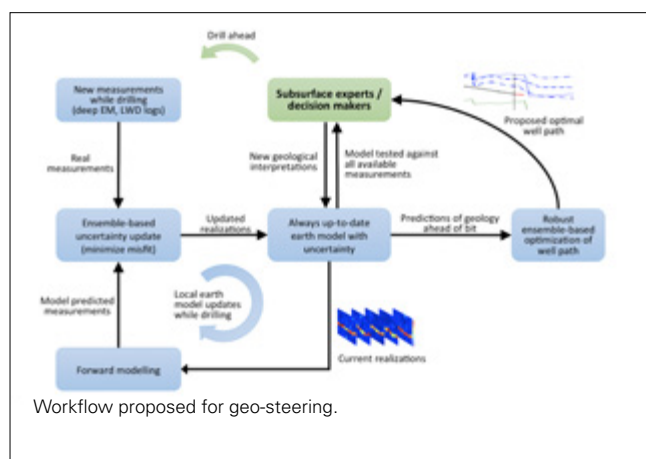
Highlights of scientific results

The cuttings transport model developed in DrillWell has been used in studies as well as implemented in products and services. Several offshore drilling operations have been assisted in selecting the optimal drilling fluid and drilling parameters.

By understanding how the cuttings can be transported out of the well, the best mud can be selected, and pump rates adjusted to optimise well cleaning. It serves as a transient model for return flow through the mud treatment equipment and is implemented by Sekal in the DrillScene software and in the DrillTronics technology for automated drilling control. Using DrillScene, Sekal supports ongoing drilling operations by advising on the selection of optimal drilling parameters. DrillTronics has been successfully used on Statfjord since 2011 and the semi-submersible drilling rig Transocean Enabler since 2017 and is in 2019 installed on five floaters in addition to fixed platforms.

The transient torque and drag model from DrillWell has been implemented in DrillTronics to enable its use on floaters. The software automates drilling process control and enables drillers to optimise and enhance the safety of their drilling operations. In the case of Transocean Enabler alone, the software helped save an estimated NOK 100 million, providing the proof of concept needed to precipitate a wider application. Transocean Enabler was the first semisubmersible rig to use a system for automated drilling control. This technology enables the use of many new digital and automated applications that allow monitoring and control of the drilling operation in real time. Also, this model has been used to analyse one-sided wear on drill-pipe tool-joints that occurred in an offshore operation and subsequently advice was given concerning adjusting the drilling operational procedures.

The increased understanding of drill string vibrations through the developments and studies in DrillWell led to the development of a software that reconstructs the actual movement of the pipe based on downhole measurements of acceleration and bending moments. This software has been used to evaluate drill-string vibrations in offshore drilling operations and will be further developed for commercialization.

The research activities on gas solubility in oil-based mud has resulted in better understanding of the dense phase. In particular methane loading capacity is much higher for linear paraffin base oil than for mineral base oil in high pressure regimes, and it was recommended to use drilling fluid with mineral base oil at such conditions.

Results obtained during the cement displacement tests with tubing left in hole have a high value potential as expenses for pulling the tubing out of hole offshore are very high, especially for subsea wells.

While developing a new three-dimensional model for annular displacement flows, Schlumberger tested the model accuracy against experimental data of Herschel-Buckley fluids obtained in DrillWell experiments.

Tools for verification of well barriers have been tested in full scale before being successfully applied in offshore wells.

Awards

ONS 2016

DrillWell, together with University of Stavanger, The National IOR Centre and IRIS, was nominated for the Best Stand Award during ONS 2016.
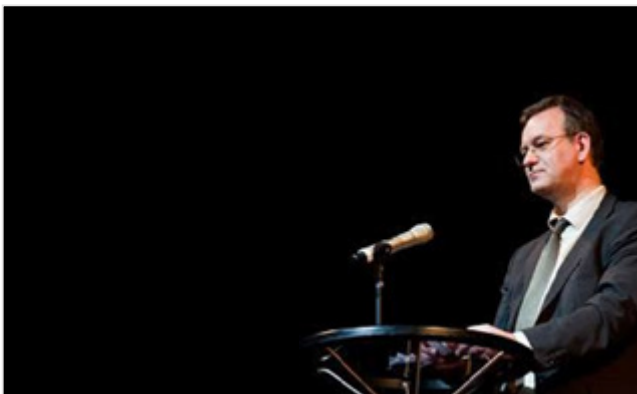
RESEARCH PRICE

Eric Cayeux, who has managed the Drilling Process Optimisation project since the beginning of DrillWell in 2011, was awarded the highly recognized research prize from Statoil in 2012 for his exceptionally good work and contributions to automated drilling. In 2019, Cayeux received the outstanding technical reviewer awards for both the SPE Journal and the SPE Drilling & Completion Journal.

Eric Cayeux awarded Statoil's research price for his work within drilling automation (Foto: Technoport/Max Hallqvist)

Tekna Technology Award

In 2018, Sekal won the Tekna Technology Award. The technology developed in DrillWell has played a key role in the development of Sekal's software. The Tekna award committee emphasized Sekal's close and long-term relationship with researchers in NORCE for bringing science and research into commercial products to benefit the drilling industry in achieving their goals.

From left: The Tekna representative, Eric Cayeux NORCE/DrillWell and Sveinung Lofthus, Sekal. Photo; Sekal: https://sekal.com/sekal-selected-for-the-tekna-technology-award-2018/

International collaboration

University of Texas at Austin, University of Houston, University of California at San Diego, Delft University of Technology, Rice University, Oklahoma State University, University of British Columbia, University of Calgary, Mines Paris Tech and Ecole des Ponts ParisTech have contributed with hosting PhD students and Post-docs and with supervision and visiting professors. The main benefits have been an exchange of experience and know-how, discussing improvements in scope of work and approaches to obtain good and relevant results. The fruitful international co-operation has resulted in 42 review papers with international co-authors, one patent together with foreign university, permanent recruitment of excellent guest researchers at the host institution and several joint projects and applications.

With financing from the research programme INTPART, DrillWell entered into a successful cooperation with SFI Offshore Mechatronics, GCE Node and the international partners Rice University in Houston and University of Texas at Austin. The focus for NorTex Data Science Cluster was to initiate and expand a cooperation regarding education and research within data analysis and energy research between universities and industry in Norway and Texas. Workshops were arranged at the Offshore Technology Conference and Exhibition and the Offshore Northern Seas Conference and Exhibition, mainly focusing on digitalization, introducing common standards, reliable and safe data, transforming data to advisory and data integration.

NORTEX DATA SCIENCE CLUSTER | Offshore Data Analytics Drilling & Well Technology

IRIS · GCE | NODE GLOBAL CENTER OF EXPERTISE · UNIVERSITY OF AGDER · RICE · TEXAS The University of Texas at Austin · SFI OFFSHORE MECHATRONICS · DrillWell DRILLING AND WELL CENTRE FOR IMPROVED RECOVERY

OTHER INTERNATIONAL COLLABORATION PARTNERS:

Delft University
of Technology

Oklahoma State University

Missouri University of
Science and Technology

Danish Hydrocarbon Research
and Technology Centre

École des Ponts, Paris-Tech

University of British Columbia,
Vancouver

In 2015 DrillWell and SFI Offshore Mechatronics initiated the NorTex Data Science Cluster, a joint cooperation with the U.S. research partners. http://nortexdatascience.org/

SINTEF, partnering with The City College of New York (CCNY) of the City University of New York (CUNY) as principal investigator, and institutions and universities in France and Germany was in 2017 awarded the PIRE project Multi-scale, Multi-phase Phenomena in Complex Fluids for the Energy Industries. PIRE (Partnerships for International Research and Education) is a very competitive 5 year grant organised by the National Science Foundation, and where 13 projects were selected of the 228 proposals submitted. SINTEF will be funded by The Research Council of Norway and will be responsible for investigating the settling of particles in non-Newtonian fluids such as drilling fluids.

The research partners have joined two EU-projects within geothermal energy recovery, Geowell and Descramble, both being funded by the Horizon 2020 programme. Geowell looked into innovative solutions for geothermal wells with extreme temperatures, focusing on the well construction phase and aiming for cost reductions. Descramble aimed at developing technologies and concepts for exploitation of deep geothermal energy, focusing especially on supercritical fluid properties and simulation and monitoring using equipment adapted to high temperature and pressure applications.

Ulf Jacob Aarnes, while working as a Post-doc at DrillWell, was granted a three-year FRIPRO mobility scholarship and has stayed at the University of California at San Diego and Mines Paris Tech.

Ten of thirteen PhD students were recruited from foreign universities and are expected to assist in expanding our international cooperation.

At the annual Celle Drilling Conference, DrillWell has presented several papers each year, and Jan Einar Gravdal, Programme Manager in DrillWell, has served as member of the Programme Committee since 2017. Results from DrillWell are being used as a basis to collaborate with German universities on geothermal drilling as well as petroleum exploitation.

Based on the activity within geosteering in DrillWell, Erich Suter was elected as Member of the SPE/EAGE Geosteering and Well Placement Workshop committee since 2018.

Eric Cayeux was a member of the organisation committee for the SPE DSATS workshop in San Antonio October 2019 and is also a member of the SPE DSATS subcommittee for drilling interoperability "D-WIS" and the committee for the "IADC Rig Sensor Stewardship Project".

Erlend H. Vefring has been a member of SPE OneDay / SPE Norway Subsurface Conference committee since 2012.

Torbjørn Vrålstad has been a technical expert in ISO/TC 67/ SC 3 Drilling Fluids and Well Cementing since 2017 and a member of the workgroup committee in Oil & Gas UK that prepared the "Guidelines on Qualification of Materials for Abandonment of Wells" in 2014-2015.

Mahmoud Khalifeh has been Topic organizer for the OMAE conference since 2017.

Based on the DrillWell efforts within permanent plugging of wells, Sigmund Stokka was invited to serve as member of the organising committee for the SPE Forum: Shaping the next wave in plugging and abandonment, arranged in Den Haag March 2019.

Sigmund Stokka has also been elected as chairperson of the SPE Drilling Engineering Subcommittee in 2020 for selecting the recipient of the SPE Drilling Engineering Award.

From left: Prof. Eric Bickel at University of Texas at Austin, Prof. Reidar Bratvold at University of Stavanger and PhD student Kanokwan Kullawan at University of Stavanger
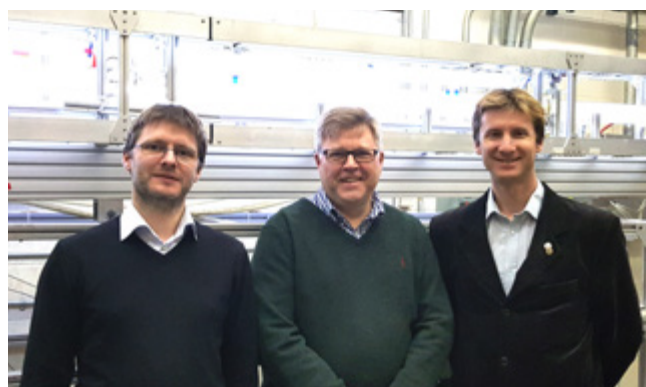
At University of British Columbia. From left: Torbjørn Vrålstad, Prof. Ian Frigaard and Jan David Ytrehus.

Training of researchers

The centre's PhD students have been recruited at the NTNU and University of Stavanger and two at NORCE. For DrillWell Phase 1, one student was already qualified and the remaining six were selected from applications following announcement nationally and internationally. The same procedure was followed for DrillWell Phase 2, announcing both nationally and internationally and resulted in a good balance between Norwegian and foreign students. The students have been part of the PhD student programmes at the two universities as well as participants of the project teams of DrillWell. Several of the students have benefitted from the access to the different infrastructures and through the close collaboration with the industry. They have participated at the DrillWell annual seminars and have contributed with high value presentations. Some of the PhD students have continued in Post-doc positions at the centre and some have entered the industry.

Master students have participated in DrillWell project teams being supervised both by professors and researchers. The DrillWell engagement within plugging and abandonment of wells contributed to the establishment of a new master course at the University of Stavanger within this field. Within drilling and well, the University of Stavanger are renewing their curriculum, and some of the results from DrillWell are being used. In particular, the simulation models from DrillWell, available through OpenLab Drilling, are used in regular courses and master theses in drilling and well technology. Computer science, modelling and mathematical methods, as well as control theory are included in the courses. This is part of the transition towards digitalization in the petroleum sector, and the need to renew the curriculum.

Employment of PhD candidates

The table below shows where the PhD students from DrillWell Phase 1 were employed after completing their PhD thesis. The Phase 2 students are in the completion phase as of September 2019.

EMPLOYMENT OF PHD CANDIDATES (NUMBER)

By centre company	By other companies	By public organisa- tions	By university	By research institute	Outside Norway	Other	Total
1			1	3	2		7

Jan Einar Gravdal, NORCE, was one of the researchers joining the Offshore Technology Conference and Exhibition in Houston on behalf of DrillWell in 2017.

Communication / Popular dissemination of knowledge

The DrillWell centre has gained national and international attention within drilling and well research. The main marketing tools have been the presentation of papers at international conferences, the annual seminar, the DrillWell newsletter and the web page.

So far over 200 scientific papers have been published and 105 of them are peer-reviewed. Additional papers are anticipated especially from PhD students finalizing their work. Another means of communicating results, has been through online education webinars organized by SPE – Society of Petroleum Engineers.

Through the presentation of useful results to the industry at project meetings, internal company meetings and seminars, at conferences and the annual seminar, the centre's results have been disseminated to the petroleum industry. Live demonstrations of prototypes have gained a particular interest and been a popular way of showing the results developed in DrillWell and the spin-off projects. Drilling Data Hub is one of the projects running several such demonstrations. Close to 30 industry representatives have participated and the final demonstration will take place in OpenLab Drilling in December 2019. A realistic environment is very valuable for shortening the time from research to prototype to product and it is also important in order to enable the industry to understand the results and how they can take them into use in real operations.

DrillWell-participants at the SPE/IACDC Drilling Conference and Exhibition in the Hague in 2017 - From left: Benoit Daireaux (NORCE), Eric Cayeux (NORCE), Hans Joakim Skadsem (NORCE), Sonja Moi (NORCE), Erlend Vefring (NORCE), Harald Linga (SINTEF), Jan David Ytrehus (SINTEF) and Torbjørn Vrålstad (SINTEF)

→

Motivated by the Macondo blowout in the Gulf of Mexico in 2010, the work on improved modelling for well control simulations has produced results for the academia. In particular, the project has led to better understanding of gas solubility in oil-based drilling muds, which is important to better understand the process during an unintended gas influx, and to maintain a safe operation in such cases. The whole article can be read in Teknisk Ukeblad.

https://www.tu.no/artikler/et-kick-i-bronnen-kan-bli-katastrofe-na-tror-norske-forskere-de-har-funnet-en-losning/276036
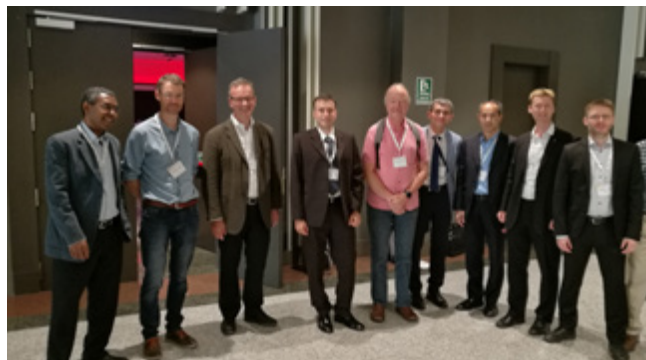
DrillWell researchers at the OMAE conference in Madrid in 2018.

Knut Steinar Bjørkevoll is presenting results from development of the Well Control Simulator at the DrillWell seminar 2018. The seminar was held at Sola Strand Hotel.

Delegates from Pertamina at the annual seminar 2019.

Delegates from Petrobras at the annual seminar 2018: Fabio Robelo, Marcelo Minto, Fafael Camel and Fabio Omara.

Prof. Andrew Wojtanowicz from Louisiana State University at the annual seminar 2019.

Ragnhild Skorpa and Anisa Noor Corina at the annual seminar 2019.

Gunnar Lende from Halliburton and Harald Linga from SINTEF at the annual seminar 2019.

Effects of the centre for the host institution and research partners

All four research partners in DrillWell have strengthened their research position within drilling and well in general, while plugging and abandonment of wells has been established as a new research area. Research activities within plugging and abandonment of wells were at a low level when DrillWell started and are now world class. Also, a new master course within plugging and abandonment of wells has been established at the University of Stavanger.

A substantial number of research spin-off projects have been established with a basis in the centre's research activities. These cover Petromaks2, Demo2000, INTPART, H2020, joint industry and single client projects within drilling automation, digitalisation, well cementing, downhole fluid flow, cuttings transport, geo-steering, downhole mechanical friction and plugging and abandonment of wells.

The grant from The Research Council of Norway to develop the OpenLab Drilling infrastructure was important for the availability of simulation models developed in DrillWell, and for the universities to improve education and research within automated drilling. The DrillWell Centre and the infrastructure in OpenLab has been mutually beneficial for the partners. The Norwegian P&A Laboratories, a new infrastructure project was granted in 2019 and DrillWell has been a key enabler of the infrastructure being established at the DrillWell partners' locations.

The activities on geo-steering in DrillWell were important to initiate a larger Petromaks2 project at NORCE and the Universities of Stavanger and Bergen: https://geosteering.no/. Geo-steering is becoming a key topic in order to improve oil recovery, and the knowledge and software developed in DrillWell, as well as the industry contacts, have been important factors to renew this research field and combine drilling and geoscience.

DrillWell as a meeting place for the academia and industry has been a great success. The Centre has contributed significantly to help bridging the gap between scientists and engineers and, as a consequence, accelerate innovation and uptake of new technology. Through regular meetings between reference groups, the technical committee, the board and the annual DrillWell seminar, a mutually beneficial collaboration has been achieved.

Effects of centre for company partners, public partners and society at large

DrillWell has been run by oil and gas operators and the academia, without commercial vendors of technology or services as partners in the centre. The objective has been to collaborate with the suppliers on a case-by-case basis to ensure benefits for all operators, independent of their choice of supplier.

Nevertheless, several of the DrillWell oil & gas operators are now using DrillWell technology commercialized through a supplier of automated drilling systems. In addition, DrillWell has contributed indirectly to improve the technology of other suppliers in projects associated with DrillWell, such as the Demo2000 projects.

It is evident that the centre has contributed significantly to drilling and well cost reductions on the Norwegian continental shelf and been one of many reasons why the cost has been reduced with close to fifty percent during the last five years. DrillWell has in particular contributed to drilling process optimisation, automated drilling control and plugging and abandonment of wells. Know-how, results and technology developed in DrillWell are used by operators and service providers.

One example is the reduction in the number of side-tracks caused by drilling problems. The oil and gas software company Sekal has improved their technology and extended their services by implementing results from NORCE, developed in DrillWell. The cutting transport model has been improved and is valuable both for their follow-up of drilling operations with their software DrillScene and for automated drilling control using their control system DrillTronics. A transient torque and drag model developed by NORCE was implemented in DrillTronics for applications on floating drilling rigs. With the use of DrillScene, only 16 technical side-tracks were reported for 180 drilled wells. By comparison, more than 30 percent of the wells drilled on the Norwegian Continental Shelf the last decade resulted in a technical side-track. It is likely that this reduction in technical side-tracks can be credited directly to the DrillScene software which has been uploaded with models from NORCE, in particular for the
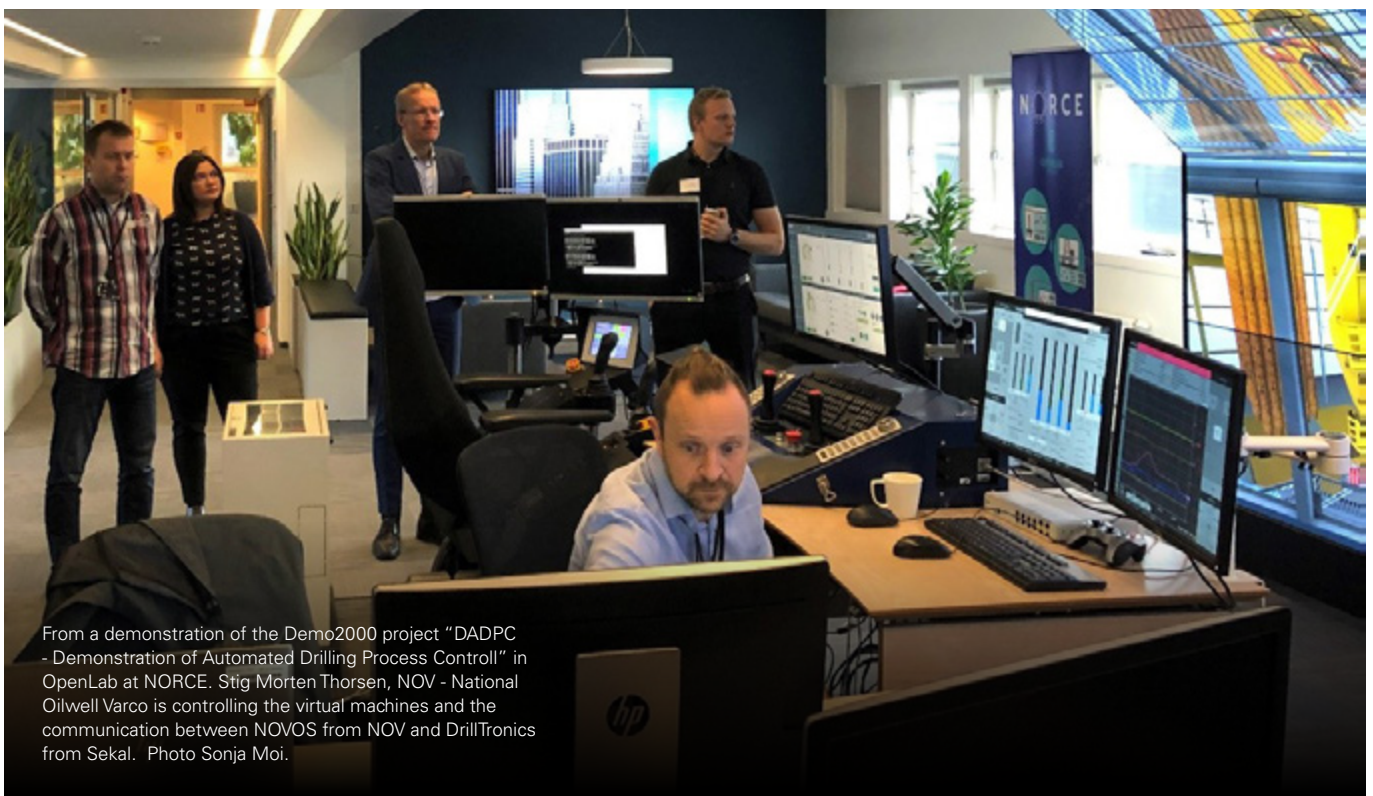
From a demonstration of the Demo2000 project "DADPC - Demonstration of Automated Drilling Process Controll" in OpenLab at NORCE. Stig Morten Thorsen, NOV - National Oilwell Varco is controlling the virtual machines and the communication between NOVOS from NOV and DrillTronics from Sekal. Photo Sonja Moi.

simulation of cuttings transport. Statistically, the reduction in technical side-tracks, results in a cost reduction in the order of 3-5 billion NOK and the reduced carbon footprint is more than 100 kilotons of CO_2. This is more than the total CO_2 emissions from all traffic in Stavanger in 2019. Of the 3-5 billion NOK, the Norwegian state directly saves 78%.

The CO_2 emissions from the oil & gas industry in Norway account for 25% of the total CO_2 emission from Norwegian territory (Statistisk Sentralbyrå, 2018 numbers). The emission from drilling rigs and vessels accounts for a substantial amount of this. Reducing the number of technical side-tracks from above 30% to below 10% in average will have a significant impact on the Norwegian CO_2 emissions. Equinor alone plan to drill 3000 more wells on the NCS to increase oil recovery, many in challenging formations, for example with depleted pressure. The results from DrillWell are therefore expected to have a high impact also in the years to come through technologies that optimise drilling processes and avoid drilling problems.

DrillWell has supervised several operators in the planning and follow-up of drilling operations on the Norwegian continental shelf and abroad, advising on the selection of drilling fluid and optimal drilling parameters to obtain good transport of cuttings out of the well while controlling the downhole pressure along the well. In one example the time for drilling the well was reduced by 45 percent, from 110 to 60 days.

A substantial contribution came from DrillWell when Equinor applied automated drilling control on a semi-submersible rig (Songa Enabler) for the first time, reporting savings of approximately 100 million NOK for two drilled sections in the Barents Sea.

For the acceleration of technology readiness and uptake of new technology within automated drilling, the newly opened infrastructure, OpenLab Drilling, plays a key role. With improved simulation models developed by NORCE in DrillWell, a test environment has been developed which is the world's most realistic virtual environment when it comes to the behaviour of the well and topside measurements during a drilling operation. The accuracy of the models allows automated drilling systems to be tested in situations that otherwise would not be possible and has been used extensively by research and industrial institutions world-wide.

Based on competencies within drilling fluid rheology and real-time well control SINTEF has together with equipment vendors, service companies and operators successfully initiated and run several DEMO 2000 projects targeting offshore automation when it comes to drilling fluid rheology prediction and control and well operations. Achieving this target has benefitted from the competence and know-how resulting from DrillWell projects.

Automated mud management has been demonstrated for the DEMO 2000 project Drilling Mud Process Control, project owner Huisman, with partners Equinor and Intelligent Mud Solutions in addition to SINTEF. During the project the robust performance of automatic mud treatment based on real-time rheology measurements has been successfully demonstrated at realistic rig conditions and for drilling operations such as Managed Pressure Drilling.

For the DEMO 2000 project Autoviscosity, project owner NOV, the goal has been to reduce product variability in mud mixing through more advanced automation. SINTEF has developed predictive models for drilling fluid rheology. The performance has been demonstrated for a range of additives in water and oil-based fluids and has been piloted both on a supply base and at an offshore rig.

For the DEMO2000 project Digitized Fluid Transport (project owner Kongsberg Digital), a software system has been developed for monitoring density, volume and rheology on fluids in transit at the dock and on the rig. This will further be demonstrated for real-time access to measured data. The software system will be a platform for digitized work-processes at and between stakeholders along the transport chain.

Our efforts to improve the lifecycle well integrity contribute both to ensuring safety and to reducing cost. New knowledge has been obtained regarding cement integrity for wells being exposed to temperature and pressure variations and test results have been obtained for the long-term stability of well plugging material.

As it is expected that around 6000 wells will be plugged and abandoned on the Norwegian continental shelf in the coming years, it is important to reduce cost while obtaining non-leaking wells. Our contribution to new knowledge supporting the ambitions of leaving the tubing in hole can be valuable in this context.

A geopolymer for use as well plugging material has been developed and patented by the University of Stavanger and is being further developed in a joint industry project.

Both large service companies and smaller, more technology specific vendors have been involved in Programme 3. Innovative tools provided by Baker Hughes, Schlumberger, Halliburton, Visuray and Probe Technologies for logging the quality of cement barriers in the well annulus have been tested, as well as tools provided by Archer, TGT and Exedra for monitoring gas leakage.

Schlumberger and Halliburton have used laboratory facilities developed at SINTEF through DrillWell for testing cements that have been designed for improved well integrity. Also, there has been an experience exchange with Halliburton in connection with the execution of full-scale cement displacement experiments and the evaluation of results.

Experimental know-how and methodologies from Programme 3 are used in research projects within renewable energy topics such as geothermal wells and carbon capture and storage (CCS).

Feedback from some active company partners

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 completing Phase 2 of the programme and our PhD candidates are finalizing their work. It is important that the scientific communities of DrillWell remain strong and able to serve the Norwegian oil and gas industry beyond the duration of the programme.

Rune Woie, ConocoPhillips

At the end of DrillWell we can look back at a program that kept steady pace, but also was changed in line with the market and industry. Early in the program the enhanced recovery was discontinued, well Plug and Abandonment (P&A) became a more important part, and the drilling projects changed to be more field data/case specific. At the same time our engineers got exposed to more theory, building awareness and new competencies that impacted ongoing operations. High drilling torque anticipated linked to hole cleaning turned more into mechanical issues, warranted and developed new measurements to understand drill string behaviour. Advanced analytics with Computational Fluid Dynamics, enhanced understanding of complex cementing and well barrier design and execution. For P&A, broader and deeper competencies and sharing of challenges, helped develop safer and more efficient facilities to test cement/barrier placement, and new tools to measure the quality of the well barriers.

Knut Sigve Selnes, AkerBP

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 DEA

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 Norwegian continental shelf and the R&D partners NORCE, SINTEF, NTNU and UiS. For Wintershall DEA 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 plugging and abandonment significantly. The centre has over the last period produced promising results enabling more efficient and predictable operations.

Future prospects

DrillWell has become a brand within drilling and well research and technology development both in Norway and abroad. It has benefitted the research partners in establishing additional research projects and the commercialization of results. The annual seminar and the DrillWell meeting place have been established with success and this is planned to be continued in the coming years, allowing for interaction between the research partners and the industry, discussions on research needs and the establishment of new research projects.

The DrillWell partners are promoting further research and innovation within the strong areas of the centre; drilling process optimisation, well control, well integrity and plugging and abandonment of wells. Achievements within automated drilling control and geo-steering could be expanded to utilizing data-driven methods, automated drilling and real time updates of reservoir models to accommodate optimal reservoir navigation at reduced cost.

The Petromaks2 project on geo-steering will continue beyond the lifetime of SFI DrillWell and future development projects are expected.

The development of a Drilling Data Hub for consistent acquisition and presentation of drilling data started in DrillWell and is being further developed in a Demo2000 project with broad industry participation. This will be a contribution 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 the different users.

After the first development and patenting of a geopolymer plugging material in DrillWell the company SafeRock was established and has strong support from oil companies.
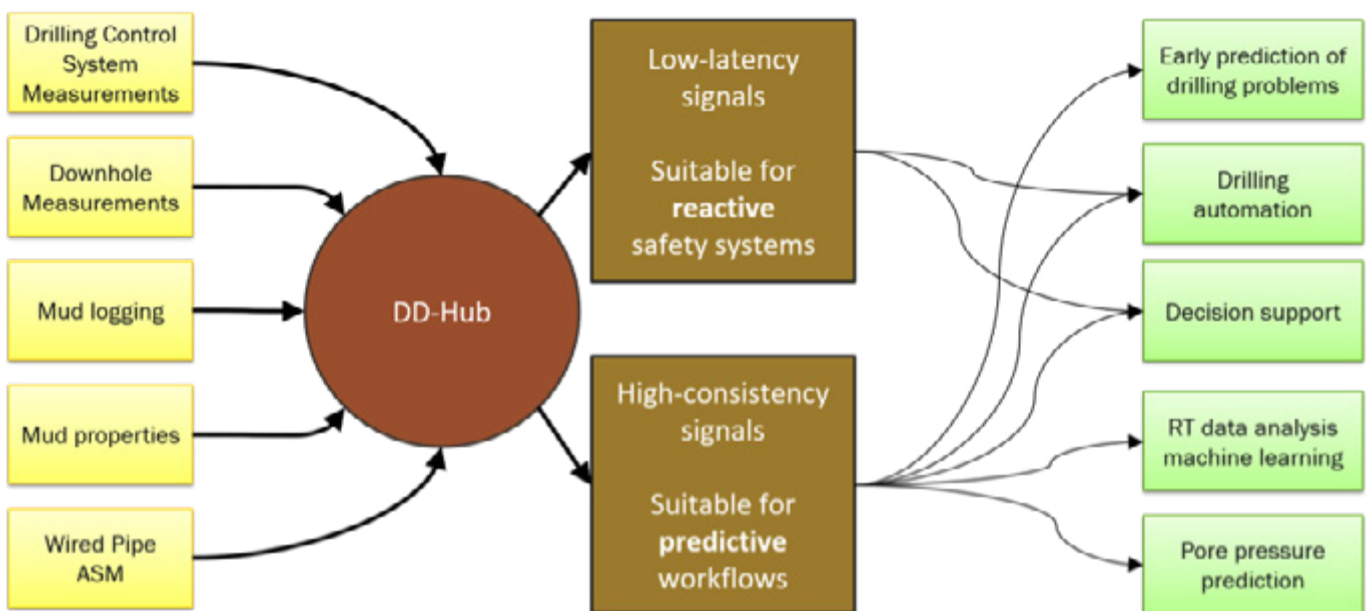
Flow of information during drilling – Intermediate interface reference implementation. DEMO2000 project Drilling Data Hub.

Based on experience and results from DrillWell, a Plugging and Abandonment Programme was established with financing from a group of oil companies, including oil companies that are not partners in the centre. This programme will utilize test cells and related equipment developed in DrillWell.

The cooperation between the research partners in DrillWell has resulted in several joint initiatives between the research partners and industry. Recently, an infrastructure grant was awarded to the DrillWell partners for the "Norwegian P&A Laboratories". This grant will support the establishment of advanced R&D test facilities for well integrity plus plugging and abandonment. The facilities cover both small, medium and large scale and will provide vehicles for further technology achievements.

Similarly, the recent SFI initiative SWIPA; Subsurface Well Integrity, Plugging and Abandonment, decision on award to be announced June 2020, is complementary to the initiative taken for industry-supported continuation of SFI DrillWell. In addition to the partners in Norwegian P&A Laboratories and DrillWell, IFE (Institute for Energy Technology) will join SWIPA. The primary objective for SWIPA is to obtain a scientific understanding of permanent well barriers and establish improved well barrier design methodologies.

Test facilities and laboratories are available at the premises of the research partners, including facilities for full scale cementing experiments and plugging and abandonment laboratories, test cells for testing well barrier logging tools, laboratory for cement integrity evaluation and laboratory for long term testing of cement plugging material. Current activities at SINTEF within renewable energy from geothermal wells and carbon capture and storage have benefitted from research results and experience gained in DrillWell.

Conclusions

Within the objective of improving drilling and well technology, DrillWell has contributed with new knowledge and innovative technology for implementation in field developments and operations. After Phase 1, that covered a broad scope of work, the research was focused within the four strongest areas: drilling process optimisation, well control, well integrity and plugging and abandonment of wells.

THE HIGHLIGHTS OF SCIENTIFIC RESULTS COVER

- Development and application of a transient model for estimating the distribution of drilling cuttings in the well and the transport to surface

- Development and application of a transient drill-string torque and drag model

- Development and application of models for drill-string torsional and axial vibrations

- Development and application of a model for reconstructing drill-string movement

- Measurements of gas solubility in drilling fluid base oil which is important for well control while drilling high-pressure and high-temperature wells

- Full scale well cementing experiments showing the potential for leaving the pipe in hole when plugging and abandoning wells

- Testing of well barrier verification tools

Within drilling process control cost savings from application of technology and knowledge developed in DrillWell sums up to several billions NOK, and the future value potential is high within all four main research areas. The reduced CO_2 emissions resulting from technology with key components from DrillWell, is order of 100 kilotons.

International attention has been obtained through the presentation of research results at international conferences, seminars and workshops and DrillWell has become a recognised brand name within drilling and well research and technology development.

All four participating research partners have strengthened their research position within drilling and well in general, while plugging and abandonment of wells has been established as a new research area and a number of spin-off research projects have been initiated.
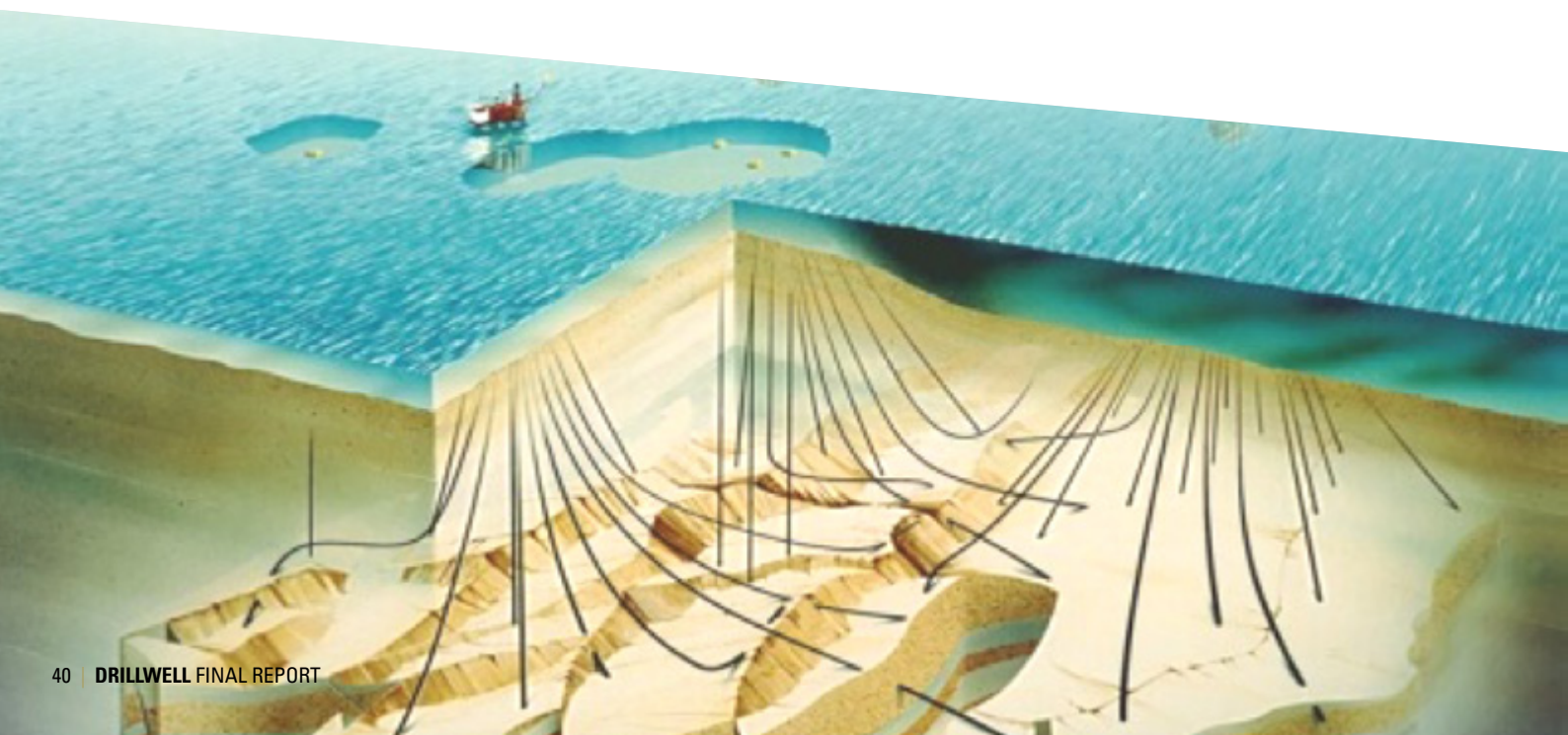
Appendix 1

FUNDING

The table below summarizes the total SFI funding reported to the Research Council during the SFI period 2011 – 2019.

Nok Million

Activity/Item	RCN	NORCE	SINTEF	UiS	NTNU	AKERBP/DET NORSKE	CONOCO PHILLIPS	EQUINOR/ STATOIL	LUNDIN NORWAY	REPSOL/ TALISMAN	Total	WINTERSHALL DEA	TOTAL
Programme 1	28					10	10	10	2	2	3	10	**73**
Programme 2	10					3	3	3	1	2	2	3	**26**
Programme 3	31					10	10	10	2	3	4	10	**82**
PhD/MSc supervision				6	4								**10**
Equipment		4	4										**8**
Management	11					4	4	4	1	1	2	4	**30**
Sum	**80**	**4**	**4**	**6**	**4**	**27**	**27**	**27**	**6**	**9**	**10**	**27**	**230**

COSTS

The table below summarizes the total SFI cost reported to the Research Council during the SFI period 2011 – 2019.

Nok Million

Activity/Item	NORCE	SINTEF	UiS	NTNU	TOTAL
Programme 1	40	26	3	4	**73**
Programme 2	14	5	4	3	**26**
Programme 3	26	35	8	12	**82**
PhD/MSc supervision			6	4	**10**
Equipment	4	4			**8**
Management	25	4		1	**30**
Sum	**109**	**76**	**22**	**24**	**230**

Programme 1: Safe and efficient drilling operations for cost reduction
Programme 2: Geo-steering and drilling solutions for improved recovery
Programme 3: Well solutions for improved recovery

Appendix 2

LIST OF POST-DOCS, CANDIDATES FOR PHD AND MSC DEGREES

Post-doctoral researchers with financial support from the centre budget

Name	M/F	Nationality	Scientific area	Years/period in the centre	Scientific topic	Main contact
Ulf Jacob Aarnes	M	Norway	Drilling Mechanics	4	Computer modelling of drillstring vibrations	Eric Cayeux
Fatemeh Moeinikia	F	Iran	Risk analysis	2	Leakage risk assessment for plugged and abandoned wells	Øystein Arild
Geir-Ove Strand	M	Norway	Well integrity	2	Well barrier analysis	Dave Gardner
Sohrab Gheibi	M	Iran	Well integrity	2	Life-cycle well integrity	Torbjørn Vrålstad

PhD candidates who have completed with financial support from the centre budget

Name	M/F	Nationality	Scientific area	Years/period in the centre	Thesis title	Main thesis Advisor
Erich Suter	M	Norway	Flexible grids	6	Novel Principles for Effictive Earth Model Grid Management while Geosteering	Terje Kårstad
Jesus Alberto De Andrade Correia	M	Venezue-la&Portugal	Well integrity	3	Cement Sheath Integrity During Thermal Cycling	Torbjørn Vrålstad
Kanokwan Kullawan	F	Thailand	Risk management	4	A Bayesian Framwork for Real-Time Optimisation of Well Placement	Reidar Bratvold
Yi Liu	F	China	Seismic imaging	3	Data-Driven Borehole Imaging and Monitoring	Børge Arntsen
Mahmoud Khalifeh	M	Iran	Well barrier materials	3	Materials for Optimised P&A Performance	Helge Hodne
Fatemeh Moeinikia	F	Iran	Well plugging and abandonment	3	Rigless P&A Technology Availability and Cost Effectiveness of Rigless P&A Operations	Kjell Kåre Fjelde
Reza Askarinezhad	M	Iran	Water management	4	Chemical Water Shuttoff and Disproportionate Permeabilty Reduction	Dimitrios Hazignatiou

PhD students with financial support from the centre budget who still are in the process of finishing studies

Name	M/F	Nationality	Scientific area	Years in the centre	Thesis topic	Main thesis Advisor
Solveig Riisøen (*)	F	Norway	Fluid rheology	3	A study on the accuracy of the modelled frictional pressure loss	Rune Time
Dalila de Sousa Gomes	F	Brasil	Well control modelling	3	Improved dynamic modelling of two phase flow in well control operations	Kjell Kåre Fjelde
Marius Staahl Nilsen	M	Norway	Well control modelling	3	Dynamic behavior of formation gas in oil-based mud	Sigve Hovda
Jacopo Paglia (**)	M	Italy	Pressure modelling	3	Statistical models for pore pressure prediction and drilling window	Jo Eidsvik
Anisa Noor Corina	F	Indonesia	Cement integrity	3	Cement plug integrity within plug & abandonment phase	Sigbjørn Sang-esland
Shreyansh Divyankar (**)	M	India	Cement integrity	3	Cementing irregular wellbore geometries	Jan Aasen

(*): Financed by NORCE

(**): Financed by Petromaks2 and DrillWell

MSc candidates with thesis related to the centre research agenda and an advisor from the centre staff

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Sakti Tanripada	M	Indonisia	Drilling technology	1	An Analysis of Poor Cutting Transport During a Problematic Drill Out Cement Operation	Kjell Kåre Fjelde	2012
Taiwo Oluwaseyi Mesagan	M	Nigeria	Drilling technology	1	Evaluation of a new cuttings transport model for prediction of severe drilling problems	Kjell Kåre Fjelde	2012
Sanggi Raksagati	M	Indonesia	Risk analysis	1	Risk based Cost and Duration Estimation of P&A operations	Kjell Kåre Fjelde	2012
Inger Kamilla Eikås	F	Norway	Well technology	1	Influence of casing shoe depth on sustained casing pressure	Sigbjørn Sangesland	2012
Fredrik Skjeldestad	M	Norway	Well technology	1	A study of how to implement alternative well plugging materials in governing regulations	Sigbjørn Sangesland	2012
Phi Long Nguyen	M	Norway	Well technology	1	Assessment of materials for primary cementing	Sigbjørn Sangesland	2012
Ali Al Bawi	M	Iran	Well technology	1	Influence of thermal cycling on cement sheath integrity	Sigbjørn Sangesland	2013
Waqas Mushtaq	M	Pakistan	Well technology	1	Experimental study on cement-formation bonding	Sigbjørn Sangesland	2013
Steven Leonardus Paulus	M	Indonisia	Well technology	1	Evaluation of Slender Well Drilling	Sigbjørn Sangesland	2013
Hans Petter Lande	M	Norway	Drilling technology	1	Analysis of the factors influencing the annulus pressure far away from downhole pressure measurements	Mesfin Agonafir Belayneh	2013
Juan Alberto Andrade Toro	M	Bolivia	Well technology	1	New technology trends for effective Plug and Abandonment	Kjell Kåre Fjelde	2013
May Bente Leifsen Valdal	F	Norway	Well technology	1	Plug and Abandonment Operations Performed Riserless using a Light Well Intervention Vessel	Kjell Kåre Fjelde	2013
Daniel Toka Eshragi	M	Norway	Well technology	1	P&A status on regulations and technology and identification of potential improvements	Kjell Kåre Fjelde	2013
Christian Steen	M	Norway	Well technology	1	P&A Operations today and improvement potential	Kjell Kåre Fjelde	2013
Øystein Røssland	M	Norway	Drilling technology	1	A discussion of well control methods	Kjell Kåre Fjelde	2013

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Vibeke Henriksen	F	Norway	Well technology	1	Plug and Abandonment on the Norwegian Continental Shelf	Helge Hodne	2013
Tore Berli	M	Norway	Well technology	1	Norite-based geopolymer as an alternative material for plug and abandonment	Helge Hodne	2013
Lars Espen Kolberg	M	Norway	Well technology	1	Geopolymerization of Norite	Helge Hodne	2013
Silje Ramvik	F	Norway	Well technology	1	Application of fly ash-based geopolymer as an alternative material for plug and abandonement	Helge Hodne	2013
Espen Simonsen	M	Norway	Well technology	1	Strength development of aplite-based geopolymer cements	Helge Hodne	2013
Moslem Ghorbanizadeh	M	Iran	Well technology	1	Experimental Study on Sandaband-based Geopolymer Cement as a Solution for Foundation of Sandaband Plug	Helge Hodne	2013
Torleiv Midtgarden	M	Norway	Well technology	1	Advancement in P&A Operations by utilizing new PWR concept from Archer	Helge Hodne	2013
Agharbi Mohamed	M	Norway	Drilling technology	1	MPD and the use of the AUSMV model to simulate and analyze propagation of pressure pulses	Kjell Kåre Fjelde	2014
Elsa Mehari	F	Norway	Well technology	1	P&A in Arctic Conditions	Kjell Kåre Fjelde	2014
Marie Brendehaug Randby	F	Norway	Well technology	1	Plug and abandonment, milling operations and simulations	Kjell Kåre Fjelde	2014
Abrar Akram Ghauri	M	Norway	Drilling technology	1	Use of the AUMSV scheme for simulation of gas migration, bullheading and Pressurized Mud Cap Drilling	Kjell Kåre Fjelde	2014
Abdullah Tariq	M	Pakistan	Well technology	1	Well stability study in shale formation	Mesfin Agonafir Belayneh	2014
Saad Idrees	M	Pakistan	Well technology	1	Plug and Abandonment Operations and Tool Positioning	Helge Hodne	2014
Sofie Stange Erland	F	Norway	Well technology	1	P&A using PWC technique and verification of the plug	Helge Hodne	2014
Jone Idsø	M	Norway	Well technology	1	Addressing zonal isolation challenges and improving 9 5/8" production liner primary cement jobs across the Valhall field	Helge Hodne	2014

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Elshan Jabrayilov	M	Azerbaijan	Drilling technology	1	Friction reduction by using nanoparticles in oil-based mud	Sigbjørn Sangesland	2014
Gutlug Jafarzade	M	Azerbaijan	Well technology	1	Leakage of CO2 along Annular Well Cement	Sigbjørn Sangesland	2014
Carolin Jahns	F	Germany	Drilling technology	1	Friction Reduction by using Nano-Fluids in Drilling	Sigbjørn Sangesland	2014
Joakim Lokna	M	Norway	Drilling technology	1	Evaluation of Work Flow in Drilling and Completion	Sigbjørn Sangesland	2014
Tarje Livik Naterstad	M	Norway	Drilling technology	1	Utilizing Managed Pressure Casing Drilling in Depleted Reservoir Zones	Sigbjørn Sangesland	2014
Line Pettersen	F	Norway	Drilling technology	1	Kick Tolerance for HPHT	Sigbjørn Sangesland	2014
Thomas Alexander Sahl	M	Norway	Drilling technology	1	Advanced Positioning for Offshore Norway	Sigbjørn Sangesland	2014
John Werne Solgren	M	Norway	Drilling technology	1	Multiphase Blowout Simulation Model	Sigbjørn Sangesland	2014
Mari Hagen Storli	F	Norway	Well technology	1	Testing and Verification of Well Barriers	Sigbjørn Sangesland	2014
Andreas Holm Strømhaug	M	Norway	Drilling technology	1	Directional Drilling - Advanced Trajectory Modelling	Sigbjørn Sangesland	2014
Stian Sætre	M	Norway	Well technology	1	Alternative Methods for Tubing Removal	Sigbjørn Sangesland	2014
Jaspreet Singh Sachdeva	M	India	Improved oil recovery	1	Evaluation of silicate and polymer systems for disproportionate permeability reduction in oil reservoirs	Dimitrious Hatzignatiou	2015
Mohammed Ahmed Iqbal	M	Norway	Drilling technology	1	Use of AUSMV scheme for simulation of particle transport	Kjell Kåre Fjelde	2015
Arne Kristoffer Torsdal	M	Norway	Drilling technology	1	Inclusion of temperature in the AUSMV scheme with simulation examples from underbalanced and mud cap drilling	Kjell Kåre Fjelde	2015
Samuel Erzuah	M	Ghana	Drilling technology	1	Hook load measurements correction with non-uniform movement	Eric Cayeux	2015
Johan Holm Østvedt	M	Norway	Well technology	1	Analysis of drilling loads in advanced casing design	Sigbjørn Sangesland	2015

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Marie Tøien	F	Norway	Well technology	1	Modell for casing design	Sigbjørn Sangesland	2015
Ole Severin Tønder Sortland	M	Norway	Well technology	1	Downhole mechanical isolation equipment - Analysis of retrieval operations	Sigbjørn Sangesland	2015
Knut Vegard Løbergsli	M	Norway	Well technology	1	Advanced temperature model for HPHT conditions	Sigbjørn Sangesland	2015
Marielle Jensen	F	Norway	Well technology	1	Optimised well design on Brage	Sigbjørn Sangesland	2015
Øyvind Breivik	M	Norway	Well technology	1	Operational procedure for permanent P&A of subsea wells	Sigbjørn Sangesland	2015
Rza Behbudov	M	Aserbadjan	Drilling technology	1	Full-Scale and Small-scale Controlled Mud Level Drilling Simulations with the AUSMV Numerical Scheme	Kjell Kåre Fjelde	2016
Jahn Otte Waldeland	M	Norway	Drilling technology	1	Inclusion of mass transfer terms in the AUSMV transient flow model	Kjell Kåre Fjelde	2016
Frank Michael Mortensen	M	Norway	Well technology	1	A New P&A technology for setting the permanent barriers	Kjell Kåre Fjelde	2016
Krister Aunan	M	Norway	Well technology	1	Method selection study of future plug and abandonment at Gjøa Field	Kjell Kåre Fjelde	2016
Alexander Steine Johnsen	M	Norway	Well technology	1	Investigation of leakage paths in well abandonment operations	Kjell Kåre Fjelde	2016
Vlad Haukelid	M	Norway	Well technology	1	A Study of Possible Approaches for Considering Well Abandonment in the Well Design Stage	Kjell Kåre Fjelde	2016
Solveig Emilie Espedal	F	Norway	Cost analysis	1	A Probabilistic Cost Estimation for Plug and Abandonment on the NCS	Kjell Kåre Fjelde	2016
Christer Halvorsen	M	Norway	Drilling technology	1	Plug and Abandonment Technology Evaluation and Field Case Study	Mesfin Agonafir Belayneh	2016
Stanislaw Wrobel	M	Norway	Drilling technology	1	Development of an improved Nanopaticle-modified water based drilling fluid	Mesfin Agonafir Belayneh	2016
Shirin Charlotte Forthun	F	Norway	Drilling technology	1	Effect of nano additives on Friction in a Bentonite Water Based System	Mesfin Agonafir Belayneh	2016

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Anne May Haaland	F	Norway	Drilling technology	1	Numerical Simulation and Experimental Study of Reelwells Heavy over Light Solution in Vertical Well Section	Mesfin Agonafir Belayneh	2016
Olaleke Anthony Akisanmi	M	Nigeria	Drilling technology	1	Automatic Management of Rate of Penetration in Heterogeneous Formation Rocks	Mesfin Agonafir Belayneh	2016
Hugo Alexandre Machado Ganga	M	Angola	Drilling technology	1	Cuttings Bed Erosion in Horizontal Wells	Sigbjørn Sangesland	2016
Daniel Vilhelm Rosland	M	Norway	Drilling technology	1	Prediction of Failures While Drilling	Sigbjørn Sangesland	2016
Andreas Øveraasen Årstad	M	Norway	Drilling technology	1	Prediction of Failures While Drilling	Sigbjørn Sangesland	2016
Alex William Mwange`nde	M	Tanzania	Well technology	1	Evidences of Poor Cement Displacement Jobs	Sigbjørn Sangesland	2016
Mehari Redae Mehari	M	Etiopia	Well technology	1	Cement Displacement Efficiency in Smooth and Rough Pipes	Sigbjørn Sangesland	2016
Priyadharshini Saptharishi	F	India	Drilling technology	1	Rheological Characterization of Water-Based Drilling Fluids	Sigbjørn Sangesland	2016
Marte Bustgaard	F	Norway	Well technology	1	Model for Prediction of Cement Sheat Failure	Sigbjørn Sangesland	2016
Marie Houge Nesheim	F	Norway	Well technology	1	Model for Prediction of Cement Sheat Failure	Sigbjørn Sangesland	2016
Malik Alsenwar	M	Norway	Drilling technology	1	NCS drilling data based ROP modelling and Application	Mesfin Agonafir Belayneh	2017
Fridrik Hilmar Zimsen Fridriksson	M	Iceland	Well technology	1	An improved cement slurry formation for oil and geothermal wells	Mesfin Agonafir Belayneh	2017
Andrew Martin Holsaeter	M	USA	Drilling technology	1	Integration of modeling and drilling incident management of a real-time lab-scale autonomous drilling rig	Dan Sui	2017
Kenny Berntsen	M	Norway	Drilling technology	1	Experimental design and setup of circulation flow loop using particle image velocimetry	Jan Aasen	2017
Muhammad Yasser Haddad	M	Norway	Well technology	1	Theoretical Study on Utilization of X-ray Techniques for Verification of Casing Cement	Mahmoud Khalifeh	2017

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Eirik Aas Lind	M	Norway	Drilling technology	1	Simulation and Modelling of Injectivity during Pressurized Mud Cap Drilling with the AUSMV Numerical Scheme	Kjell Kåre Fjelde	2017
Sondre Jakobsen Fagerås	M	Norway	Well technology	1	A Novel Tool for Cement Evaluation	Sigbjørn Sangesland	2017
Even Gunnarsson Øyan	M	Norway	Well technology	1	Evaluation and Testing of Thermoset Polymer Resin for Remedial Repair of Sustained Casing Pressure	Sigbjørn Sangesland	2017
Adil Isgandarzada	M	Azerbaijan	Drilling technology	1	Cuttings Bed Erosion	Pål Skalle	2017
Birgitte Ruud Kosberg	F	Norway	Drilling technology	1	Cuttings Transport in Inclined Sections	Pål Skalle	2017
Jude Chibuike Egbue	F	Nigeria	Drilling technology	1	Improving The Efficiency Of Transportation Of Cuttings In Wellbore	Pål Skalle	2017
Tone Carlsen	F	Norway	Drilling technology	1	Surface volume control through continuous surveillance of drilling data	Pål Skalle	2017
Erling Bendiksen Bjørndal	M	Norway	Well technology	1	Reliability-Based Casing Design with Focus on an APB Collapse Scenario	Kjell Kåre Fjelde	2018
Muhammed Mahmoud Abdelrhman Elsheikh	M	Sudan	Well technology	1	Modelling and Simulation of Annular Pressure BuildUp	Kjell Kåre Fjelde	2018
Arnela Kljucanin	F	Australia	Well technology	1	Qualification of Settled Barite as Permanent Barrier	Mahmoud Khalifeh	2018
Espen Dommersnes	M	Norway	Well technology	1	Potential Utilization of Neutron logging Tools for Verification of Casing Cement	Mahmoud Khalifeh	2018
Luize Sobreiro de Oliveira	F	Brazil	Drilling technology	1	MPD-Field case Studies, Modelling and Simulation studies	Mesfin Agonafir Belayneh	2018
Eirin Lillevik	F	Norway	Drilling technology	1	Automated generation of parametric wellbore trajectories minimizing wellbore lengths	Sigbjørn Sangesland	2018
Per Hammersland Mjelde	M	Norway	Drilling technology	1	Drilling equipment erosion	John-Morten Godhavn	2018
Trine Remmen	F	Norway	Well technology	1	Evaluation of industry practice for buckling analysis in well design	Bjørn Astor Brechan	2018

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Ivar Wathne Oftedal	M	Norway	Formation physics	1	Rock properties in synthetic and natural clay materials	Erling Fjær	2018
Eilen Bauge	F	Norway	Well technology	1	Improved burst model for casing and tubing design	Sigbjørn Sangesland	2018
Anatoly Kurman Rivero	M	Venezuela	Risk analysis	1	Estimation of Expected Lifetime of Highly Reliable Systems using Bayesian Analysis	Jon T. Selvik	2019
Hanh Pham	F	Vietnam	Risk analysis	1	A Model for Assessment of Environmental Risk related to Oil Leakage from Abandoned Wells	Daniela Maria Pampanin	2019
Qenehelo Alice Leuta	F	South Africa	Risk analysis	1	Modelling possible environmental risks of gas leakage from abandoned wells	Daniela Maria Pampanin	2019
Keino Roxman	M	Norway	Drilling technology	1	Boundary Conditions Treatment in a Transient Flow Model	Kjell Kåre Fjelde	2019
Karoline Nyhus	F	Norway	Well technology	1	A comparison of working stress design and reliability based casing design	Kjell Kåre Fjelde	2019
Hassan Hmayed	M	Norway	Drilling technology	1	Ormen Lange 6305/7 Drilling Data Based ROP modelling and its Application	Mesfin Agonafir Belayneh	2019
Bevin Babu	M	India	Drilling technology	1	Alternative Applications of Wired Drill Pipe in Drilling and Well operations	Mesfin Agonafir Belayneh	2019
Simen Moe Strømø	M	Norway	Drilling technology	1	Formulation of New Drilling Fluids and Characterization in HPHT: Experimental, Modelling and Simulation Studies	Mesfin Agonafir Belayneh	2019
Øystein Kristiansen	M	Norway	Drilling technology	1	Oseberg South oil field's Dynamic underbalanced perforation: Experimental and Simulation studies	Mesfin Agonafir Belayneh	2019
Erik Andreas Løken	M	Norway	Drilling technology	1	Optimisation of an Intelligent Autonomous Drilling Rig: Testing and Implementation of Machine Learning and Control Algorithms for Formation Classification, Downhole Vibrations Management and Directional Drilling	Dan Sui	2019

Name	M/F	Nationality	Scientific area	Year(s) in the centre	Thesis title	Main thesis Advisor	Year
Jens Løkkevik	M	Norway	Drilling technology	1	Optimisation of an Intelligent Autonomous Drilling Rig: Testing and Implementation of Machine Learning and Control Algorithms for Formation Classification, Downhole Vibrations Management and Directional Drilling	Dan Sui	2019
Muhammad Suleman	M	Pakistan	Drilling technology	1	Influence of measured thermophysical parameters of drilling fluids on downhole temperature models	Dan Sui	2019
Tonje Garpestad Tønnesen	F	Norway	Drilling technology	1	An experimental study of gas migration in pressurized fluids	Sigbjørn Sangesland	2019
Lise Johnsen Rønning	F	Norway	Drilling technology	1	Evaluation of vibration mitigation technologies	Bjørn A. Brechan	2019
Marius Berge-Skillingstad & Viktor Hamre Anderssen	M	Norway	Drilling technology	1	drillWiz: An application for data visualization and drilling optimisation	Bjørn A. Brechan	2019
Joakim Nornes	M	Norway	Drilling technology	1	Automation of Blow-Out Preventer Testing	Tor Berge S. Gjersvik	2019

Appendix 3
DRILLWELL PUBLICATIONS

JOURNAL

Aarsnes, U.J.F., Acikmese, B. and Ambrus, A., Aamo, O.M. 2016. ''Robust Controller Design for Automated Kick Handling in Managed Pressure Drilling''. Journal of Process Control, vol 47, Nov, 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. and Aamo, O.M. 2016. ''Review of two-phase flow models for control and estimation''. Annual Reviews in Control, vol 42, p 50-62.

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.

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., Busch, A. 2018. ''Transient modeling of one-dimensional solid-liquid flow in conduits''. International Journal of Multiphase Flow, Volume 105, August, pp 102-111.

Aarsnes, U.J.F., Wouw, N.v.d. 2019. ''Axial and torsional self-exited vibrations of a distributed drill-string''. Journal of Sound and Vibration, Vol. 444, March.

Aarsnes, U.J.F., Auriol, J., Di Meglio, F., Shor, R. 2019. ''Estimating friction factors while drilling''. Journal of Petroleum Science and Engineering, Vol. 179, August.

Aarsnes, U.J.F., Wouw, N.v.d. 2019. ''Effect of shock subs on self-exited vibrations in drilling systems''. Journal of Petroleum Science and Engineering, Vol. 181, October.

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.

Alyaev, S., Suter, E.C., Bratvold, R.B., Hong, A., Luo, X., Fossum, K. 2019. ''A decision support system for multi-target geosteering''. Journal of Petroleum Science and Engineering, Vol. 183, December.

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. 2015. ''Establishing an experimental pre-conditioning procedure for rheological characterization of oil based drilling fluids''. Annual Transactions of the Nordic Rheology Society, Vol. 23, 2015.

Auriol, J., Aarsnes, U.J.F., Martin, P., Meglio, F. 2018. ''Delay-robust control design for two heterodirectional linear coupled hyperbolic PDEs''. IEEE Transactions on Automated Control, Volume 63, Oct.

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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, Pages 91-105, January.

Cayeux, E., Daireaux, B., 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.

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Corina, A.N., Skorpa, R., Sangesland, S., Vrålstad, T. 2019.''Fluid flow analysis of different fluid types through real microannuli''. Submitted for journal publication.

Corina, A.N., Skorpa, R., Sangesland, S., Vrålstad, T. 2019. ''The effect of casing pipe roughness on cement plug integrity''. SPE Drilling and Completion 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 Volume: 147, pp 682-698. Published: Nov.

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., Skorpa, R., Todorovis, S., Vrålstad, T. 2016. ''Experimental Laboratory Setup for Visualization and Quantification of Cement-Sheath Integrity''. SPE Drilling and Completions, SPE.173871-PA.

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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., 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.

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Khalifeh, M., Saasen, A., Larsen, H.B., Hodne, H. 2017. ''Development and Charecterization 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.

Khalifeh, M., Gardner, D., Haddad, M.Y. 2018. ''Technology Trends in Cement Job Evaluation Using Logging Tools''. Journal of Petroleum Technology, Vol 70, Issue 05, pp. 74-77.

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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, Volume 64 (2), pp. 348-360.

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Liu, Y., van der Neut, J., Arntsen, B., Wapenaar, K. 2016. ''Data-driven deep local imaging near horizontal wells using both surface and borehole data''. Geophysical Journal International, Volume 205 (2), pp. 758-775.

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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.

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

Paglia, J., Eidvik, J., Grøver, A., Lothe, A.E. 2018. ''Statistical modeling for real-time pore pressure prediction from predrill analysis and well logs''. Geophysics. vol. 84 (2).

Paglia, J., Eidvik, J, Cerasi, P. 2019. ''Uncertainties in mud-weight window for safe drilling operations''. Submitted to SPE Journal.

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, pp. 73-85.

Renteria, A., Maleki, A., Frigaard, I. A., Lund, B., Taghipour, A., Ytrehus, J. D. 2019. ''Effects of irregularity on displacement flows in primary cementing of highly deviated wells''. Journal of Petroleum Science & Engineering, Vol 172, pp. 662-680.

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

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

Skadsem, H.J., Kragset, S., Lund, B., Ytrehus, J. D., Taghipour, A. 2019. ''Annular displacement in a highly inclined irregular wellbore: Experimental and three dimensional numerical simulations''. Journal of Petroleum Science & Engineering, Vol 172, pp. 998-1013.

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Torsvik, A., Skogestad, J.O., 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 and Completion.

Vrålstad, T., Saasen, A., Fjær, E., Øia, T., Ytrehus, J.D., Khalifeh, M. 2018. ''Plug & abandonment of offshore wells: Ensuring long-term well integrity and cost-efficiency''. Journal of Petroleum Science and Engineering, Volume 173, February, Pages 478-491. Online Oct. 17, 2018.

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, Col 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''. 3rd IFAC Workshop on Automatic Control in Offshore Oil and Gas Production OOGP 2018, May 30- June 1, Esbjerg, Denmark.

Aarsnes, U.J.F., Aamo, O.M., Krstic, M. 2019. ''Extremum seeking for real-time optimal drilling control''. American Control Conference, Philadelphia, July 10-12.

Aarsnes, U.J.F., Vazquez, R., Di Meglio, F., Krstic, M. 2019. ''Delay robust control design of under-actuated PDE-ODE-PDE systems''. American Control Conference, Philadelphia, July 10-12.

Arild, Ø., Lohne, H.P., Skadsem, H.J., Ford, E.P., Selvik, J.T. 2019. ''Time-to-failure estimation of barrier systems in permanently plugged and abandoned wells''. ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2019, June 9-14, Glasgow, Scotland, OMAE2019-96546.

Bjørkevoll, K. 2015. ''Use of High Fidelity Models for Real Time Status Detection with Field Examples from Automated MPD Operations in the North Sea''. 2nd IFAC Workshop on Automatic Control in Offshore Oil and Gas Production, May 27-29, 2015, Florianópolis, Brazil.

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 Transmission of an Automatic Small Scale Drilling Rig''. In Proceedings of the ASME 2017 36th International Conference on Ocean, Offshore and Arctic Engineering, OMAE, June 25th-30, Trondheim, Norway.

Cayeux, E., Leulseged, A. 2018. ''Modelling of Drilling Fluid Thixotropy''. ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain, OMAE2018-77203.

Cayeux, E. 2019. ''Modelling of the movement of a prolate particle in the steady state flow of a non-newtonian fluid in an inclined annulus with inner string rotation''. ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2019, June 9-14, Glasgow, Scotland.
Cayeux, E., Leulseged, A. 2020. ''Characterization of the Rheological Behavior of Drilling Fluids''. OMAE 2020, Florida.

Cerasi, P. 2018. ''Evaluation of uncertainty in mudweight window from error propagation considerations''. Proceedings of 10º Congreso de Exploración y Desarrollo de Hidrocarburos, 7-9 Nov, Mendoza, Agentina.

Gomes, D., Bjørkevoll, K.S., Fjelde, K.K., Frøyen, J. 2020. ''Gas Suspension Effects in Riser Unloading and Appropriate Modelling Approaches''. OMAE 2020, Florida.

Corina, A.N., Opedal, N.T., Vrålstad, T., Sangeland, S. 2019. ''Cement plug sealing studies of silica cement systems''. ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2019, June 9-14, Glasgow, Scotland, OMAE2019-95928.

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''. ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, 2018, Madrid, Spain, OMAE2018-77515.

Dvergsnes, E.W., Cayeux, E. 2019. ''On the importance of the coupling between transient mechanical, hydraulic and thermal effects for the modelling of real-time drillling operations''. ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2019, June 9-14, Glasgow, Scotland, OMAE2019-95062.

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Gheibi, S., Sangesland, S., Vrålstad, T. 2019. ''Numerical modeling of radial fracturing of cement sheath caused by pressure''. ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2019, June 9-14, Glasgow, Scotland, OMAE2019-96319.

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 25th-30, Trondheim, Norway.

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''. ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain.

Gomes, D., Bjørkevoll, K.S., Fjelde, K.K., Frøyen, J. 2019. ''Numerical modelling and sensitivity analysis of gas kick migration and unloading of riser''. ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2019, June 9-14, Glasgow, Scotland, OMAE2019.

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.

Kragset, S., Skadsem, H.J. 2018. ''Effect of buoyancy and inertia on viscoplastic fluid-fluid displacement in an inclined eccentric annulus with an irregular section''. ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain, OMAE2018-77519.

Lamare, P.O., Auriol, J., Di Meglio, F., Aarsnes, U.J. 2018. ''Robust output regulation of 2 x 2 hyperbolic systems: Control law and Input-to-State Stability''. Presented to the American Control Conference (ACC), Milwaukee, USA, 27-29 June.

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Lund, B., Ytrehus, J. D., Taghipour, A. et al 2018. ''Fluid-fluid displacement for primary cementing in deviated washout sections''. ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain, OMAE2018-78707.

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

Opedal, N., Corina, A.N., Vrålstad, T. 2018. ''Laboratory Test on Cement Plut Integrity''. ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, 2018, Madrid, Spain, OMAE2018-78347.

Sayindla, S., Lund, B., Taghipour, A., Werner, B., Saasen, A., Gyland, K.R., Ibragimova, Z. and 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, 2016, Busan, South Korea.

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Skadsem, H.J., Kragset, S. 2019. ''Effect of buoyancy and inertia on viscoplastic fluid-fluid displacement in an inclined eccentric annulus with an irregular section. Part 2: Displacements in vertical annulus''. ASME 2019 38th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2019, June 9-14, Glasgow, Scotland, OMAE2019-95700.

Skorpa, R., Øia, T., Taghipour, A., Vrålstad, T. 2018. ''Laboratory Set-Up for Determination of Cement Sheath Integrity during Pressure Cycling''. ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2018, June 17-22, Madrid, Spain, OMAE2018-78696.

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PRESENTATIONS WITHOUT PAPER

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

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''. 9th European Nonlinear Dynamics Conference.

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Arild, Ø., 2018. ''P&A leakage risk assessment''. The annual DrillWell Seminar, September 25-26, Stavanger.

Arild, Ø., 2019. ''A framework & software tool for quantifying P&A leakage probability and rates''. The annual DrillWell Seminar, September 24-25, Stavanger.

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''. The annual DrillWell Seminar, September 25-26, Stavanger.

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

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

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

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

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, 19-20. Invited speaker.

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''. Borekonferansen i Kristiansand, September 17-19, Kristiansand.

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

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

Cayeux, E., Stokland, L. 2018. ''Tool Joint Wear''. The annual DrillWell Seminar, September 25-26, Stavanger.

Cayeux, E., 2019. ''Downhole high frequency measurements enable detailed reconstruction of lateral drill pipe movement''. The annual DrillWell Seminar, September 24-25, Stavanger.

Cayeux, E., 2019. ''Stick-slips and side-effects from downlinking procedures during drilling operations in the Eldfisk and Ekofisk fields''. The annual DrillWell Seminar, September 24-25, Stavanger.

Cerasi, P. 2018. ''Evaluation of uncertainty in mudweight window from error propagation considerations''. 10° Congreso de Exploración y Desarrollo de Hidrocarburos, Argentina, 2018.

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

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

Corina, A.N., Skorpa, R., Sangesland, S., Vrålstad, T. 2019. ''Fluid flow analysis of different fluid types through real microannuli''. The annual DrillWell Seminar, September 24-25, Stavanger.

Daireaux, B., 2018. ''Drilling Data Hub''. The annual DrillWell Seminar, September 25-26, Stavanger.

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''. 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, 12-13 September.

Gardner, D., 2016. ''DrillWell P&A projects''. DEA meeting, St. Andrews, Scotland, 15&16 September.

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

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

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

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

Gardner, D., 2017. ''Technologies for cement verification''. European Drilling Engineering Association DEAe, London, August 1.

Gardner, D., 2017. ''Well P&A, evaluating the barrier system quality''. Kristiansandkonferansen innen Boring og Brønn, September 18.

Gardner, D., 2017. ''Test facility for cement evaluation''. The annual DrillWell seminar, Sola Strand Hotel - September 26&27, 2017.

Gardner, D., 2017. ''Barrier verification and leakage risk''. Norsk Olje & Gass P&A Seminar, October 18.

Gardner, D., Andersen, M.I. 2018. ''Cement performance evaluation testing with a new broad spectrum acoustic tool''. The annual DrillWell Seminar, September 25-26, Stavanger.

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

Gomes, D., 2019. ''Numerical modelling of gas kick migration and unloading of riser''. The annual DrillWell Seminar, September 24-25, Stavanger.

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, 2 May.

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

Grimstad, A.A., 2016. ''Gas release from drilling fluid during depressurization''. 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, November 4-7, Cape Town, South Africa.

Hagen, H., Jakobsen, A. 2019. ''UiS Drillbotics 2019-2020 ''. The annual DrillWell Seminar, September 24-25, Stavanger.

Hodne, H., 2017. ''Synthetic rock barriers, Geopolymers''. SINTEF Conference - Experimental P&A research for the North Sea, 20-21 March, 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''. DEA€urope Meeting Q1 2016, Vlaardingen.

Jimenez, K.B., 2019. ''Leakage Measurements of a Casing-Cement Sheath-Tubing System Reproducing Sustained Pressure Conditions''. Celle Drilling Conference, Celle, Germany, 10-11 September.

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

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

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

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

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

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

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, June 21-22, Milano, hosted by ENI. Organized by OTM.

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

Lothe, A.E., 2019. ''Data integration and real-time decision making''. SINTEF Petroleum Conference, Trondheim, March 19-20.

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

Moeinikia, F.,Saasen, A., Raksagati, S., Fjelde, K.K. and 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.

Pavlov, A., Sangesland, S. 2019. ''NTNU Drillbotics 2019''. The annual DrillWell Seminar, September 24-25, Stavanger.

Petersen, J., 2019. ''The Advantages of Measuring and Analyzing the Methane Absorbed in OBM In-Line During Drilling Operations''. Celle Drilling Conference, Celle, Germany, 10-11 September.

Riisøen, S., Iversen, F. 2019. ''Experimental uncertainty study of laminar pipe flow using a non-Newtonian drilling fluid''. Poster at Nordic Rheology Conference, Gøteborg.

Riisøen, S., 2019. ''Uncertainty in frictional pressure loss modelling of pipe flow for a non-Newtonian drilling fluid''. Annual European Rheology Conference, poster.

Riisøen, S., Iversen, F. 2019. ''Experimental investigation of the accuracy of the modelled frictional pressure loss for annular pipe flow based on Rheological characterization of a non-Newtonian drilling fluid''. Workshop on Frontiers of Uncertainty Quantification in Fluid Dynammics, Pisa, 11-13 sep, poster.

Skadsem, H.J., 2017. ''Cementing irregular wellbore geometries''. The annual DrillWell seminar, Sola Strand Hotel - September 26&27, 2017.

Skadsem, H.J., 2018. ''Cementing Irregular Wellbore Geometries''. SPE February Meeting, February 7, Stavanger, Norway.

Skadsem, H.J., 2018. ''Full-scale cementing experiments in an irregular annulus geometry''. The annual DrillWell Seminar, September 25-26, Stavanger.

Skogstad, J.O, Bjørkevoll, K.S., Frøyen, J., Linga, H. 2019. ''New methodology for case studies of well control incidents''. The annual DrillWell Seminar, September 24-25, Stavanger.

Skorpa, R. 2018. ''Cement sheath integrity during pressure cycling''. The annual DrillWell Seminar, September 25-26, Stavanger.

Skorpa, R.,Werner, B., Vrålstad, T., Gheibi, S., Sangesland, S. 2019. ''Cement sheath integrity: Experimental tests and numerical modelling''. The annual DrillWell Seminar, September 24-25, Stavanger.

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

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

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

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

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

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

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

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

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

Suter, E.C., 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, 15-20 January, Geilo, Norway.

Sælevik, G., 2018. ''Digital Drilling''. SPE February Meeting, February 7, Stavanger, Norway.

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., 2014. ''Cement sheath integrity during thermal cycling''. SPE-173871-MS presented at DEA Dec. 5.

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

- Teknisk Ukeblad, December 2010. ''Boresenter vil øke sikkerheten''.

- Stavanger Aftenblad, September 2011. ''Stavangers første prestisjesenter''.

- Stavanger Aftenblad, October 2013. ''7000 milliarder kroner mer til Norge med bedre teknologi''.

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

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

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

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

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

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

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

- Stavanger Aftenblad, Interview with Kristin Flornes 2015. ''Alt er ikke svart – lavere oljepris og omstilling gir også muligheter''.

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

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

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

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

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

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

- Teknisk Ukeblad, 2017. Khalifeh. M. 2017. Sementerstatning for plugging av oljebrønner.

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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