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GMN March 2023 Technical Meeting – Agenda

Topics: 1) Pore Pressure and Fracture Gradients While Drilling
– Including MPD / Open hole / DPPT / Interpretations
2) Real Time Experiences

Date: Tuesday 28th to Wednesday 29th March 2023

Time: Tuesday: 08:15 – 17:10 (EUR time)
Wednesday: 08:15 – 15:30 (EUR time)
Wednesday joint GMN/GIN tour: 15:45 – 17:45 (EUR time), then joint dinner

Dinner: Aker BP invite all GIN and GMN Attendees to join them for a hosted dinner on Wednesday 29 March at Grand Café, Karl Johans gt. 31, 0159 Oslo. Dinner is at 7.30pm

Meeting location: **Scandic St. Olavs Plass**, St Olavs Plass 1, Oslo, 0165 Norway

Accommodation: **Scandic St. Olavs Plass**, St Olavs Plass 1, Oslo, 0165 Norway
For more information about the hotel and its facilities, visit their website

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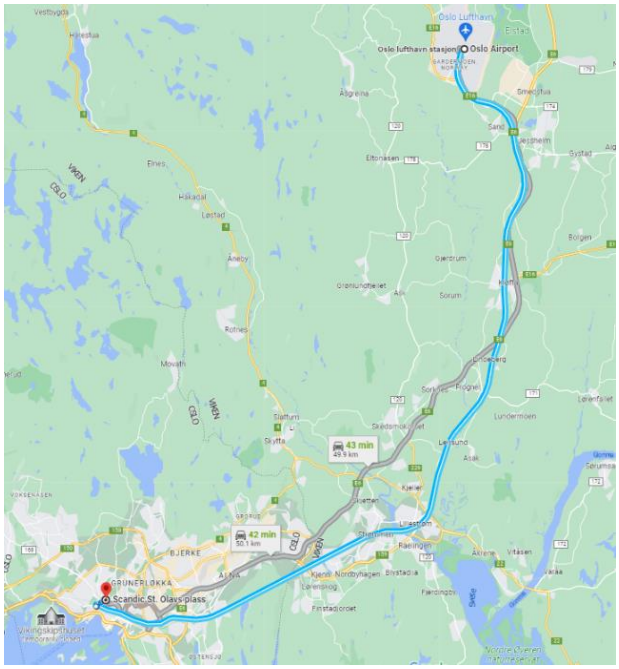
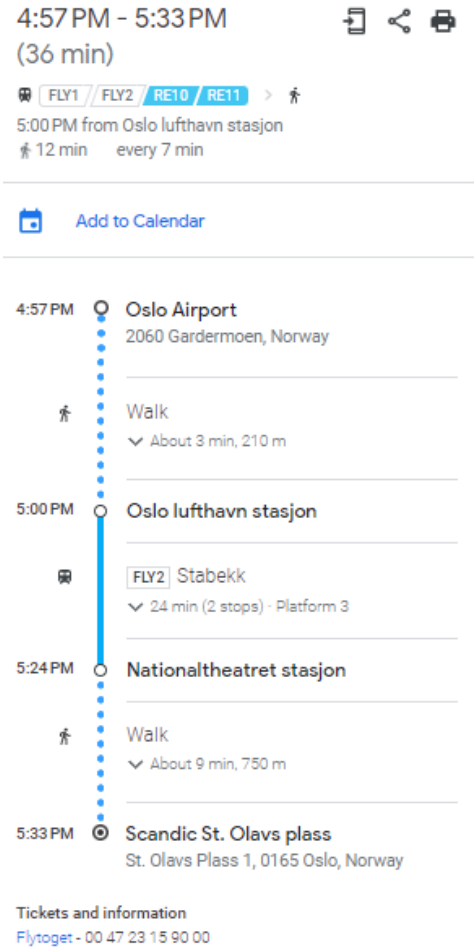
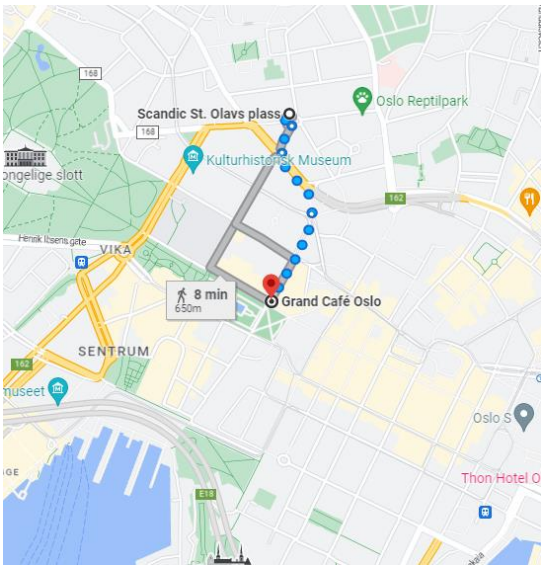
Nearest Airport: Oslo Airport – 41 mins to Scandic Hotel by taxi or train.
Train price approximately EUR 46







Scandic St Olavs Plass Hotel to dinner location at Grand Café:

Attendees:

	Company	First Name	Last Name
1	Aker BP	Tron Golder	Kristiansen
2	Aker BP	Assia	Guida
3	Aker BP	Jochen	Martin
4	Aker BP	Andreas	Bauer
5	CNOOC	Stephan	Petmecky
6	CNOOC	Tommy	Sheldrick
7	Eni S.p.A	Gianfranco	Bagnoli
8	Eni S.p.A	Federica	Ferrari
9	Eni S.p.A	Giulia	Gallino*
10	Eni S.p.A	Riccardo	Mandrioli
11	Neptune Energy	Latifa	Qobi*
12	Neptune Energy	David	Ginger*
13	OMV	Oliver	Knoop*
14	OMV	Martin	Riedl*
15	OMV	Ahmed	Saadi*
16	OMV	Thomas	Kuhn*
17	OMV	Joseph	Coyle*
18	OMV	Mira	Persaud
19	OTM Networks	Dawn	Dukes
20	OTM Networks	Justin	Weeks
21	Repsol S.A.	Sara	Martinez
22	Repsol S.A.	Johann	Fernandes
23	Shell	Dean	Thorpe*
24	Shell	Tom	Sinclair*
25	TotalEnergies	Olivier	Chailan*
26	TotalEnergies	Remigius	Obodoeze
27	TotalEnergies	Gareth	Yardley

* virtual attendees

Tuesday 28 March 2023			
	Arrival for sign in followed by tea/coffee		08:15
1	Safety briefing		08:30
2	Welcome and objectives for the meeting	Aker BP OTM Networks, Justin Weeks	08:35
3	Introductions	All	08:45
4	A practical approach of estimating the impact of tectonic strains on Shmin and FG	Aker BP, Andreas Bauer	09:00
	Tea/ coffee break		10:00
5	MDP and pore pressure follow-up, an additional tool to drill in challenging pressure context but with limitations: case study from an intense drilling campaign offshore Guyana-Suriname basin	TotalEnergies, Olivier Chailan / Remigius Obodoeze	10:20
6	A Predrill model uncertainty implications during real time drilling experience: A case study of an exploration well in a North Sumatra frontier location	Repsol, Johann Fernandes	11:20
	Lunch		12:20
7	Best Practice Guidelines 1 Workshop to develop best practice guidelines: “Best practices on how to predict pore pressure in source rock”	Justin Weeks / All	13:20
	Tea/ coffee break		14:50
8	Understanding the source of pumps off gas in impermeable rock	Shell, Dean Thorpe	15:10
9	Examples of pore pressure and fracture gradient monitoring while drilling with MPD technology in different explorative and development contexts	Eni, Riccardo Mandrioli	16:10
	End of day one		17:10

Wednesday 29 March 2023			
	Arrival with tea/ coffee		08:15
10	Day two welcome	OTM Networks, Justin Weeks	08:30
11	Pressure and geomechanics detection in unconventional wells	Repsol, Sara Martinez	08:35
12	Connection gases revisited [or surprises during infill well drilling and how to avoid them]	CNOOC, Stephan Petmecky	09:35
	Tea/ coffee for troubleshooting workshop		10:35
13	Best Practice Guidelines 2 - Continuation from Day 1		10:55
	Lunch		12:00
14	Pore pressure detection using RT methods, a case study: deviating from pre-drill model with well control incident & supercharging/ ballooning	OMV, Oliver Knoop	13:00
15	Real-time pore pressure, fracture gradient and wellbore stability surveillance and updating experiences in Aker BP	Aker BP, Jochen Martin / Tron Golder Kristiansen	14:00
16	Meeting Wrap up - Feedback from meeting; your technical takeaways – each company - Date/Topics for future meeting(s) - Host offers - AOB	OTM Networks, Justin Weeks	15:00
	Meeting Close for virtual attendees		15:30
17	Tour of Norwegian Geotechnical Institute, Sandakerveien 140, 0484 Oslo		15:45
	Meeting Close		17:45
	Dinner: There will be a joint dinner for GMN and GIN members		19:30

Abstracts

1. Aker BP, Andreas Bauer

Title: A practical approach of estimating the impact of tectonic strains on Shmin and FG

We typically apply the Matthews&Kelly method for estimating minimum horizontal stresses (Shmin) and fracture gradients (FG), with the k0 parameter that relates horizontal and vertical effective stresses calibrated against data from leak-off tests (LOT) or extended leak-off tests (XLOT). The k0 values depend on depth, pore pressure, and lithology. We show that for the Norwegian continental shelf, the k0 values can be predicted from prognosed pore pressure, that overburden gradient, and sonic/seismic velocities by applying a pore-elastic model that includes a simple description of tectonic strains.

2. TotalEnergies, Olivier Chailan and Remigius Obodoeze

Title: MDP and pore pressure follow-up, an additional tool to drill in challenging pressure context but with limitations: case study from an intense drilling campaign offshore Guyana-Suriname basin

TotalEnergies has recently undertaken an intense drilling campaign on the Atlantic margin in the Suriname Guyana basin. This Tertiary-Cretaceous basin is characterized by a very high sedimentation rate in late tertiary generating massive overpressure and consequently a very narrow drilling window. In addition, a very active aquifer with good drainage in the main zone of interest leads to highly drained pressure in reservoirs, whereas it is not uncommon to cross disconnected and highly pressurized small sand bodies between 100 to 200m above with delta P of tens to hundreds of bars.

In such a complex context, it is almost mandatory to use MPD system and early kick detection to react quickly and optimize the drilling architecture while drilling. Yet MPD system is not a guarantee of safety and it should not be always considered as a direct measurement of the pressure seen in the well.

In this presentation we will show, through a case study, the limitations of the use of MPD to assess pressure regime and how it can lead to misinterpretation and operational risks.

3. Repsol, Johann Fernandes

Title: A Predrill model uncertainty implications during real time drilling experience: A case study of an exploration well in a North Sumatra frontier location

Introduction:
The most common drilling issues encountered while drilling require extra drilling days and therefore, an associated extra cost. For this reason, the geomechanical and the pore pressure discipline expertise should work close with the drilling team to bring the most value while drilling execution. A case study is presented, to show the implications of the pore pressure and geomechanical models while drilling an exploration well located in a frontier basin with limited offset well data.

Offshore Well Case Study:
The wellbore stability analysis and pore pressure models defined the well design when drilling an exploration well offshore Sumatra Basin. The case study was based on the stress tensor magnitude contrast when crossing a main active fault. The tectonic setting corresponds to a main thrust belt front with limited available data.
The main active fault and well lithologies conclude with a well design with a small drilling window (< 1ppg) and reduced the well design contingency options. The limited window made the PPFG updates during well execution been critical to decide the contingency casings and mud weights to operate.

The differences in the stress tensor regime are evidenced between the fault hanging and foot-wall zones indicated by the offsets well analysis. The inverse thrust fault effect was perceived while drilling in the hanging wall with a pore pressure interpretation higher than the predrill high case scenario with important instabilities. Meanwhile, the footwall interval highlighted a remarked transition zone with no reported instabilities in the area.

Conclusion:
The active fault effects were responsible of pore pressures above the high pore pressure predrill scenario. The main events expected when crossing the fault were losses and/or gains. Nevertheless, the wellbore perturbation had greater impact at the entire hanging wall block, where no analogy from the offset well data was encountered.

The high stress magnitudes along the hanging wall block were represented by a high deviatoric stress and evidenced from hole instability during tripping in/out operations. In the contrary, along the footwall interval, the stresses were more isotropic with higher mean effective stress and therefore, lower instability evidence.

The Managed Pressure Drilling service (MPD) was a key tool that allowed the reduction of the drilling window uncertainties with dynamic test implemented while drilling the section, and to assess rapid responses on the hydrostatic pressure reduction and increase.

4. Shell, Dean Thorpe

Title: Understanding the source of pumps off gas in impermeable rock

While drilling, an increase in background and onset of connection gas is frequently related to an increase in pore pressure within a formation. This can lead to the risk of being near balanced or underbalanced resulting in the possibility of a kick when the pore pressure is greater than the static mud weight. This work shows that in some cases this is unlikely to be the leading interpretation and reacting to the gas by increasing the mud weight can exacerbate the situation.

5. Eni, Riccardo Mandrioli

Title: Examples of Pore Pressure and Fracture Gradient monitoring While Drilling with MPD technology in different explorative and development contexts

In the last years, more and more often wells were planned in challenging and complex settings. MPD drilling is becoming a key technology, not only in complex explorative contexts, but also in strongly depleted development fields.

MPD allows drilling wells not drillable or too expensive with conventional overbalance drilling, due to narrow mud weight window. In explorative contexts, proper use of MPD technology guarantees safer drilling conditions and allows a more accurate while drilling understanding of Pore Pressure and Fracture Gradient. In development fields and near field exploration, MPD allows drilling safely wells strongly affected by depletion due to production activity. Nevertheless, MPD is a complex technology that requires rig time for installation and setting, skilled and well-trained personnel on the rig site and that could be affected by failures.

The presentation will show different case studies, where PPFG monitoring While Drilling with MPD technology was used in different explorative, near field and development contexts. Proposed case studies will focus on how MPD can be properly used in different explorative settings, characterized by a narrow mud weight window; and on how MPD could be fundamental in near field and development contexts, where explorative targets are located below reservoir depleted by production. These themes will be discussed trying to not leave out the more operative aspects like possible failures and requirements in terms of time and personnel experience.

6. Repsol, Sara Martínez

Title: Pressure and Geomechanics detection in unconventional wells

Many has been discussed and shared about real time pore pressure detection for conventional oil and gas wells. Most of the wells have some monitoring service depending on the well complexity. Data is frequently acquired while drilling for many reasons, one of them is to enable the pressure and geomechanics real time monitoring and assessment.

On the other side are the unconventional assets, the presentation will discuss the particularities of the pressure and geomechanics real time monitoring in these types of projects. Normally developing unconventional assets are less expensive than conventional fields, and the wells seem to be less problematic than the oil and gas conventional wells. Usually in unconventional wells the data streamed while drilling is very limited and the special characteristic of the source rocks difficult the pressure monitoring. Drilling is very intensive with various rigs at the same time and wells that are drilled in less than a week, problems in such conditions are common, e.g., underbalance drilling, wellbore instability, faults, losses...

Making decisions while drilling in unconventional wells requires to have the available data integrated (drilling parameters, geosteering models, structural models, gas data, offset wells...). For this purpose, the real time centers are key at having 24hr streaming and monitoring of all the rigs and wells drilled simultaneously. An example of this configuration will be shown to demonstrate the added value of those centers in the unconventional drilling assets.

7. CNOOC, Stephan Petmecky

Option 1: Connection gases revisited
Interpreting wellsite gas responses throughout the drilling process is one of the many techniques to help with real-time PPFG interpretation. However, gas readings will be affected by many variables, such as trap type and position as well as ROP, hole size, flow rate and recycling.
In this presentation we will discuss potential real-time challenges regarding the use of wellsite gas readings when attempting to detect and even quantify overpressure in low permeability rock. Some of the questions we attempt to answer are: Who is typically responsible for lagging gases and how is it done correctly? How accurate can we expect to be when converting a time-based response to a drilling depth? Does the typical connection gas response really work in mudstones and what should it look like? Which values are representing 'background' versus 'connection' gas, how are they picked/calculated and who does it? Should gas data always be normalized? How can we differentiate between a lithology which contains more dissolved gas and underbalanced conditions during a connection?

We will present examples from recent wells, both conventional and MPD, to discuss and (possibly) answer some of the above questions.

Option 2: Surprises during infill well drilling and how to avoid them
Using the example of a recent infill well, we will discuss the importance of continuously updating and rigorously assuring PPFG models, especially for wells drilled late in the life of a field, some of which might reach further and can be highly deviated. The quality and accuracy of the field-wide reservoir model plays a key role in preventing costly surprises. Even when the impact of pressure depletion on stresses within each reservoir has not been investigated or measured in detail, the reservoir model will at least provide the magnitude of pressure depletion (or pressurization). Various stress path parameters can then be applied to capture the potential impact on fracture initiation pressures within these reservoirs.
We will demonstrate that integrating pressure data analysis with all available off-set well data, especially from the most recent wells, can challenge 'accepted' reservoir models and result in improved PPFG predictions.

8. OMV, Oliver Knoop

Title: Pore pressure detection using RT methods, a case study: deviating from pre-drill model with well control incident & supercharging/ ballooning

For an exploration well on the Norwegian continental shelf (NCS) RT-PP evaluation was planned and covered by OMV-HO personnel combined with an onsite PP specialist.

Part time & virtual involvement of OMV-HO staff was done in the early phase (calibration of NCTs in the overburden). During drilling of the critical 12 ¼" section onwards 24/7 coverage was provided with nightshifts onsite and dayshifts from onshore office using RT-data streaming.

A pre-drill geomechanical model was used as a guidance to the understanding of the PPFG profiles. RT PP specialists analyzed Logging/Measurement While Drilling data (L/MWD), surface logging data (mudlogging), Wireline data (WL) and drilling behaviour to estimate PPFG, while making real-time recommendations for safe and efficient drilling.

While drilling towards the reservoir section it became obvious that observations from PP-evaluationdeviated significantly from the pre-drill model, which, in the end, concluded in setting the casing higher then planned due to the increasing PP.

As per plan the MW was increased before drilling the reservoir section.

Even though, shortly after drilling out of the casing, an inflow was detected and the well had to be shut-in. Subsequently well-control was regained and after bleeding of the pressure the well could be drilled to planned well-TD.

After an extensive formation evaluation program including coring and wireline formation testing, the interpreted PP could be confirmed.

Conclusion
Observations from RT-PP monitoring led to early casing setting depth and lowered the severity of a subsequent inflow event due to the increased MW for the reservoir section. Though the well-control incident could not be prevented, the impact, with initially planned MW, would have been significantly different.

In addition, the well-control incidents behavior provided valuable LL with regards to supercharging/ballooning from MW increase.

9. Aker BP, Jochen Martin and Tron Golder Kristiansen

Title: Real-time Pore Pressure, Fracture Gradient and Wellbore Stability Surveillance and Updating Experiences in Aker BP

Pore pressure and fracture gradient is the key input to designing a well. It determines the number of casing strings needed to safely drill to the targeted formation in the subsurface. The question is not if the pore pressure and fracture gradient prognosis is uncertain, but how uncertain it is. In this presentation we will discuss our experiences with state-of-the-art real-time pore pressure monitoring offered by large service providers in the industry on some of our HPHT exploration wells. We will also discuss real-time pore pressure, fracture gradient and wellbore stability technologies we are developing, testing and implementing as part of our digitalisation efforts towards autonomous drilling.