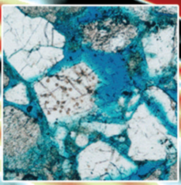
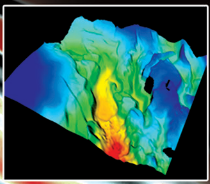
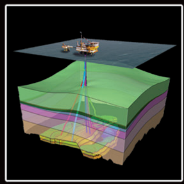

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Operations Geology in 2020 and Beyond:

Traditional and modern approaches

4-5 November 2020

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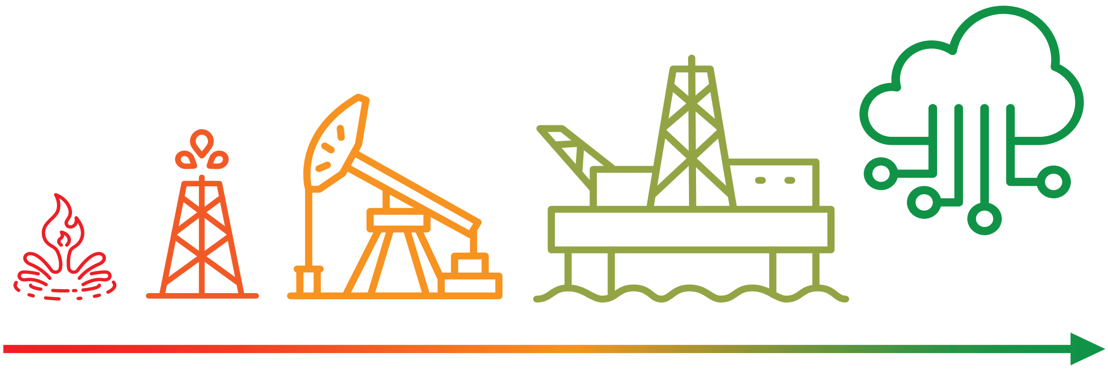

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KEYNOTE 'Accelerate and foster industry collaboration to enable Geoscience innovation at scale, based on open standards and platforms for rapid deployment - vision and lessons learned'

Joy Bhattacharjee & Ole Evensen

IMB

A new era of business reinvention is dawning. Organisations are facing an unprecedented convergence of technological, social and regulatory forces with a concerted effort towards 'Net Zero' with a rapid move to Energy Transition. Upstream Oil and Gas is experiencing increased pressure to high-grade the hydrocarbon portfolio and improve production at a lower cost, in a sustainable way.

How can new "exponential digital technology" be applied to develop new organisational capabilities? 'Intelligent workflows' underpinned by AI, built on Hybrid-cloud will be critical to achieve the necessary cross-disciplinary decision to meet these business objectives.

Drawing examples from the real-life use cases, projects and lessons learned the keynote will throw some lights on how to:

- Enable geoscientists and engineers improve planning of operations
- Support real time data driven decision-making during drilling
- Extract insight from historical data as corporate accessible knowledge
- Leverage open standards and collaborative platforms such as OSDU and others

Session One: Digital Applications in Operating Geology

Realtime Automated Lithology, Machine-learning using Drilling Parameters and LWD logs to Predict Lithology and Geological Risks at the Bit

Linn Arnesen, Rune Tendenes Kristiansen, Anne-Christin Kamlund Ringdal, Margaux Ledieu, Raymond Wiker, Harald Eggen, Olav Kåre Vatne, Li Deng
Equinor ASA

Equinor has placed the former wellsite geologists in an onshore 24-7 Geo Operation Centre (GOC) to support the execution of development wells. The GOC's geoscientists are following-up and evaluating several drilling operations simultaneously. Their responsibility is to give input and make decisions with regards to well placement and drilling operations. Realtime interpretation of lithology and formation fluids in place are mainly based on logging while drilling logs (LWD), supported by cuttings descriptions by offshore mudloggers. Drilling parameters are used to better understand the characteristics/properties of the rocks being drilled and the behavior of the well and hole conditions. The lithology interpretation is important for geosteering, placing the well in the correct formations and for continuously evaluating the geological risks while drilling, tripping and when running the casing/liner.

REaltime Automated Lithology (REAL) is an in-house technology that delivers realtime automated lithology and geological risk predictions for a more efficient and truly realtime generation of a Trip Risk Log. The Trip Risk Log is a tool for the driller to handle downhole risks in the best possible way. Well critical observations for a Trip Risk Log are: enlarged hole (washouts), cavings, overpull, tight hole, ledges, weak formations, fault zones, lost circulation, inflow intervals, high dogleg areas and poor wellbore geometry.

The REAL technology is based on hybrid models, combining machine-learning and analytical algorithms. Lithology and geological risks are predicted in 8 different steps – or tiers, in where the accuracy of each interpretation is increasing with each new dataset. Drilling parameters are registered at bit depth, while the LWD data appears with a time/depth delay, depending on how far behind the bit the various sensors are placed. Tier1 is purely based on drilling parameters and is predicted at actual bit depth at any time. Tier2 is based on drilling parameters plus gamma ray – and is predicted at the depth of the gamma ray sensor, usually 3-9m behind the bit. Tier3-tier7 include the resistivity, neutron, density, caliper and gas data; subsequently predicted at the sensor depth of each data type. Tier 8 also includes the petrophysical model for the actual field.

The Troll Field has 3-4 drilling rigs, which are continuously drilling multi-lateral branches in the reservoir and the historical data set for realtime data includes several hundreds of drilled wellbores. The reservoir consists of 4 main lithologies with pronounced differences in properties. The Troll Field's reservoir section was the first test with REAL; predicting lithology and trip risk realtime based on machine-learning and deploying the results in our realtime data viewer for continuous follow-up and QC of the Trip Risk Log. The Troll Tier8 model achieved after a few months 96% accuracy compared to a manual interpretation by experienced geoscientists. The model based on drilling parameters (Tier1) reached an accuracy of 72%, being able to register hard stringers and potential ledges immediately in the Trip Risk Log.

The business case for the REAL includes faster and improved trip risk evaluations, fewer technical sidetracks, more effective workflows and automatic reporting in the Geo Operations Centre. Other benefits are earlier detection of formation change, better geosteering and input to total depth (TD) decisions, potential opportunities for continued drilling even if one of the main logs fails, depending on the confidence of the model.

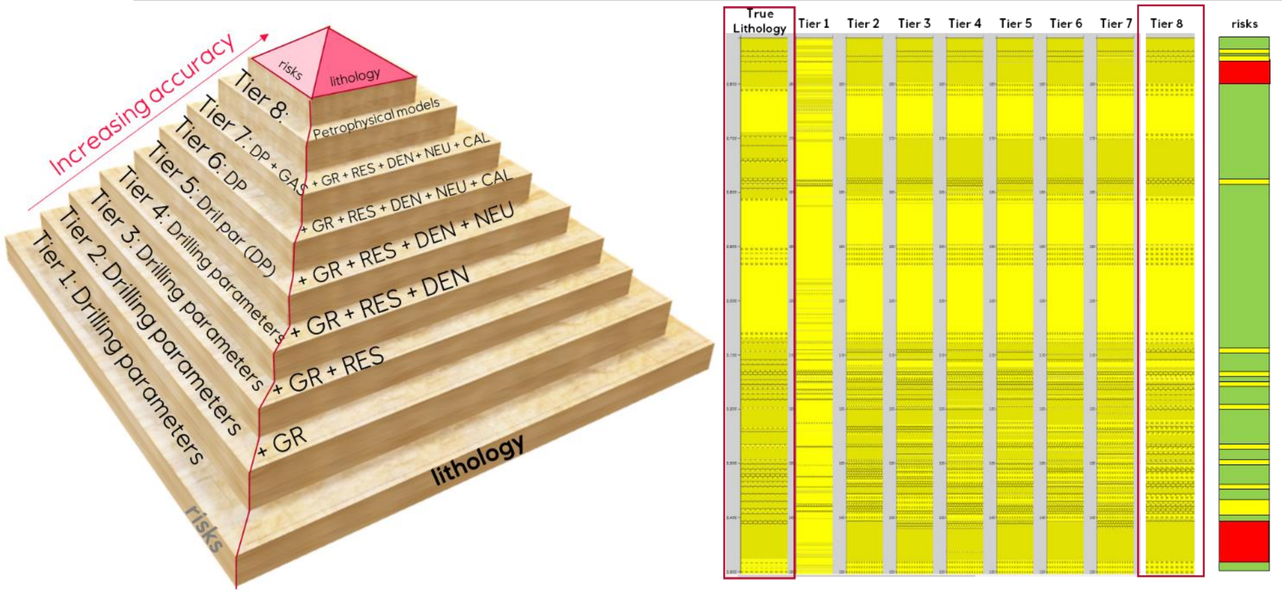


Figure text: The 8 steps (tiers) and input data for the REAL technology presented next to the true lithology and automatic trip risks.

Revamping lithology interpretation for the digital rig

Alice Butt,Tim Ferriday and Jiazuo Zhang

Operations geology has a fast paced, data heavy work environment and so the tools that are used should handle the demands of the job with clear and simple displays and efficient workflows. Lithology data in particular can be interpreted multiple times and presented in many different ways, and so this is one area that can be streamlined and standardised through innovative applications. The issues that are commonly seen in the lithology interpretation workflow stem from poor data connections and redundant steps leading to duplication of data. The real time transfer of mudlog data from the rig to onshore offices is part of the solution, however another solution to these issues is found in assisted lithology interpretation (ALI). We have applied machine learning techniques to LWD or wireline data to analyse the most likely lithology that the curve data represents and ensure that the operations geologist can get the full benefit of the raw data. This can remove some of the subjectivity in the interpretations and act as an overview of the log curve inputs, to allow the operations geologist to oversee more data rapidly and to support the wellsite geologist's interpretations. A further part to the ALI solution that we have implemented is the integration of the lithology interpretation tools within one streamlined workflow so that one standardised lithology dictionary is applied to all the data. Through these new tools we are able to reduce non-productive time, create fast interpretations and bring clarity to the operation geologist's work.

Tech Byte: Digital Well Construction Collaboration is ensuring one Truth

Ole Gunnar Tveiten, Kristian Solem
AGR

AGR has designed, planned and managed drilling campaigns since 2000. During this time, we have delivered over 540 well projects without any major incidents. To keep track of; experience, performance and cost is the essence and how we do this, is presented here.

Over the years our **iQx** software applications have evolved and is now an efficient suite of applications independent of suppliers, operators and organizations; **OA**-offset analysis, **P1**-time&cost estimation, **CT**- time&cost tracker, **Ex**- Experience and newly launched **D2** - A collaborative software for planning and reporting. Currently 1000+ users in 15+ companies are using **iQx** suite of applications.

This presentation is about D2, a revolutionary tool for planning, operations and reporting. It is organized with an easy to use menu and is a sequence driven tool, where different suppliers, managers, geologists and engineers can find together in a collaborative work environment.
Construction planning, execution and reporting of wells has always been collaborative work between operations geologists, drilling engineers and service companies. The work entails many people and organizations; interacting to achieve good results. The challenges are:

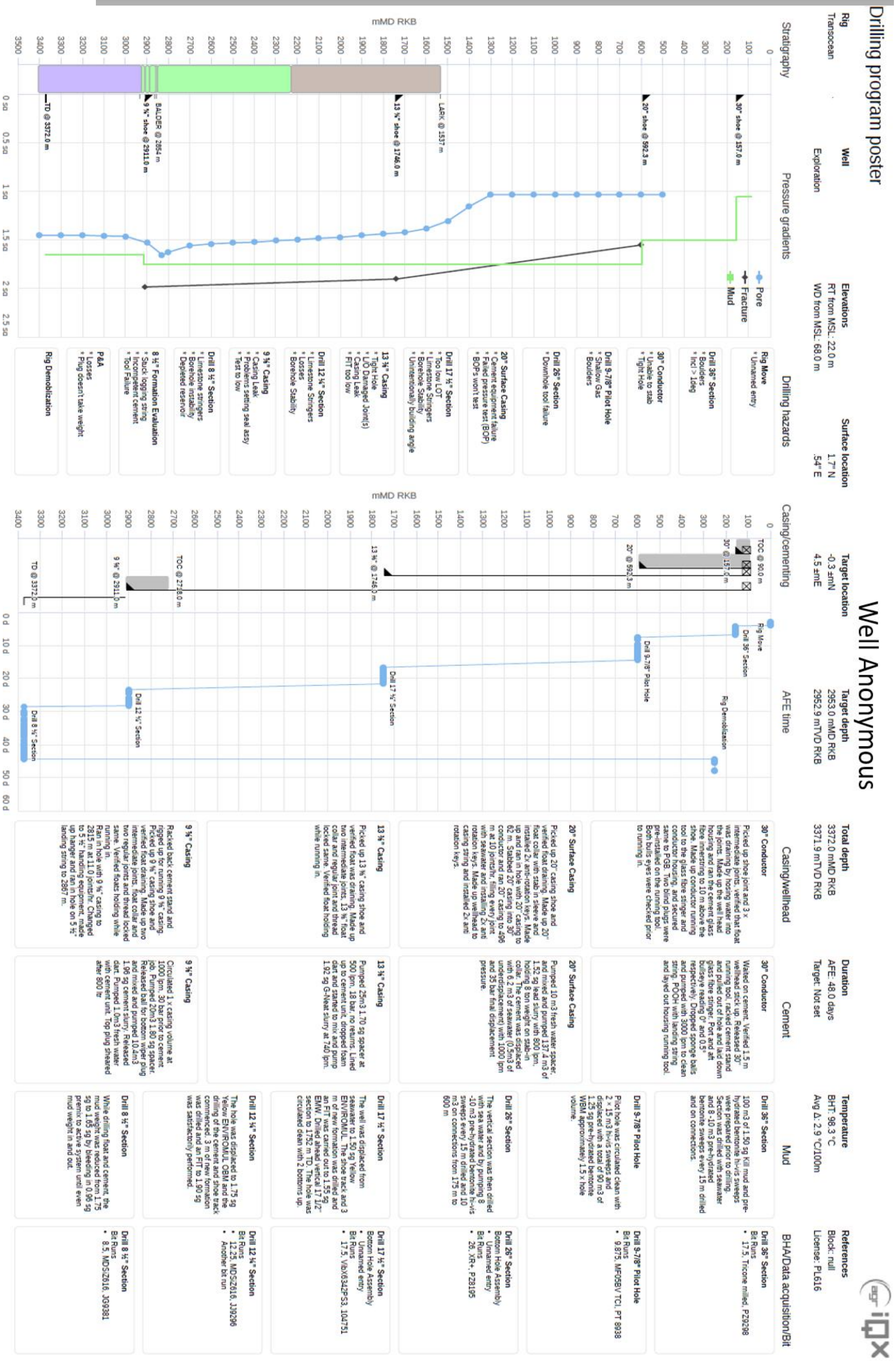
1. Lessons learnt from experiences in the area must be captured and made available
2. G&G basis of design (pressure constraints) to be an integral part of well design
3. Well design is to be an interactive and iterative process making good and efficient choices
4. Data acquisition program is a collaborative effort between suppliers, drilling engineers and operations geologists

D2 is a focal point for planning in terms of different inputs to a drilling program and experiences/lessons learnt in the end of well report. The application works seamlessly with tabular inputs and text where various contributors make up parts of the program and reports, ensuring one digital truth. The application is interactive with OA, P1, CT, Ex and is ideal for the current situation of digital meetings and remote collaborations. "*We may never go back to endless travels and meetings!"*

The operations geologist and the drilling engineer will both benefit from capturing and utilizing well experiences into the current well planning. For the geologist the formation incident reports such as; lost circulation, cavings, connection gas, tight hole etc. are captured from the daily reports and are filtered by; formation, well and sections. Any of the digital daily reporting systems are supported.

Interaction between the operators, contributors and service providers is facilitated through forms and input tables, with request by date, approval and final consent, to end up with one efficient digital truth - the drilling program. Figure below shows an example of automated well planning montage.

End of well reporting has been a bit of a low priority in many companies, thus usually more time consuming than necessary. In D2 all contributors are engaged and requested to do their contribution online with a deadline. In this way the end of well report is generated automatically and timely. This ensures a consistent format, capturing all relevant information.


Drilling program poster
Well Anonymous
Rig
Transocean
Well
Exploration
Elevations
RT from MSL: 22.0 m
WD from MSL: 68.0 m
Surface location
Target location
Target depth
2953.0 mMD RKB
2952.9 mTVD RKB
Total depth
3372.0 mMD RKB
3371.9 mTVD RKB
Duration
AFE: 48.0 days
Target: Not set
Temperature
BHT: 98.3 °C
Avg Δ: 2.9 °C/100m
References
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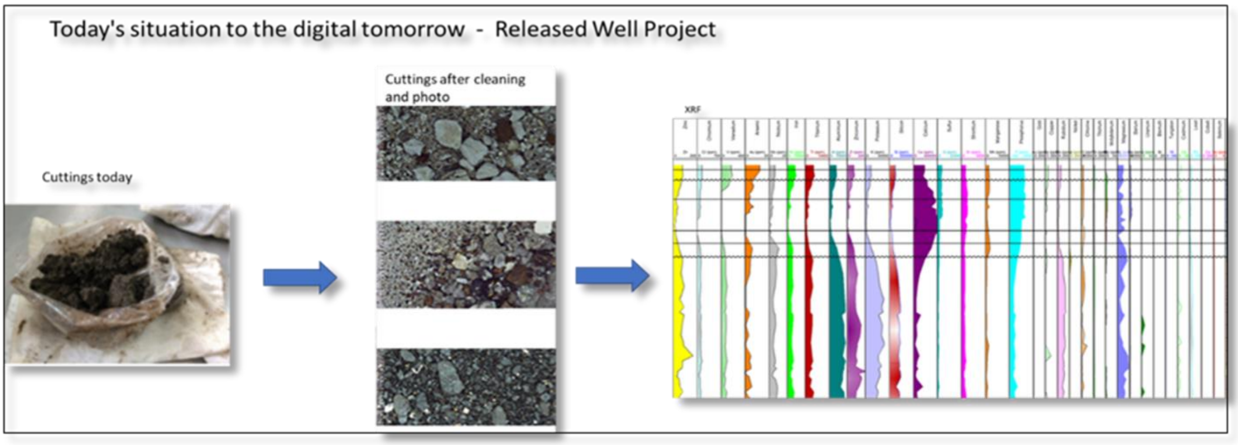
Stratigraphy
Pressure gradients
Drilling hazards
Casing/cementing
AFE time
Casing/wellhead
Cement
Mud
BHA/Data acquisition/Bit
mMD RKB
Pore
Fracture
Mud
30" shoe @ 157.0 m
20" shoe @ 592.3 m
LARK @ 1537 m
13 ⅜" shoe @ 1746.0 m
BALDER @ 2854 m
9 ⅝" shoe @ 2911.0 m
TD @ 3372.0 m
Rig Move
Drill 36" Section
30" Conductor
Drill 9-7/8" Pilot Hole
Drill 26" Section
20" Surface Casing
Drill 17 ½" Section
13 ⅜" Casing
Drill 12 ¼" Section
9 ⅝" Casing
Drill 8 ½" Section
8 ½" Formation Evaluation
P&A
Rig Demobilization
TOC @ 90.0 m
TOC @ 2758.0 m
TD @ 3372.0 m

Tech Byte: Released Wells Initiative-Norwegian Oil and gas association digital drilling cuttings project

Malgorzata Kusak;
Norsk Olje og Gass (NOROG)



The Released Well Initiative aims to revitalize old data (cutting samples) from all released wells on Norwegian Continental Shelf by making them digital accessible.
The Released Wells Initiative is owned and organized by Norwegian Oil and gas association and funded by almost all licenses owners on the Norwegian Continental Shelf. The project aims to make a large volume of historical drilling cuttings digital in order to improve geological stratigraphic control and evaluate drilling issues based on geological information.
The main purpose for the Released Wells Project is to systematically analyze all the cuttings samples for the majority of the existing ~1500 exploration and appraisal wells on NCS that has been released to the public before 1st of January 2019. An average exploration well has between 300 and 400 cutting samples. Therefore, the project will analyses close to 600 000 cuttings samples creating standardized, big data.
Such a huge data base will create an efficient way to allow for “Big data” analysis and give the fundament for integration within a whole range of disciplines.
The project key elements are:
Use cuttings to get more information about the geology, mineralogy and rock properties to be able to reduce well cost in overburden and define new play types
The project shall have a short lead time and make minimum 50 well data available every month (30months project)
All data to be digital and shareable across NPD, companies and academia, released through DISKOS
The main goals for the project:
Reduce risk by enabling an interdisciplinary approach, relevant both for subsurface evaluations, drilling and production
Reduced costs and “save” wells
Make new hydrocarbons discoveries
All the cuttings samples will go through a sequence of consistent laboratory, non-destructive analysis with high resolution photographing (both white and UV lights) and XRF. The boxes with cuttings bags and buckets will be pulled off the shelves of the storage facility. Every single cutting sample, usually every 10m in the overburden and 1-3m intervals in the reservoir, will be washed and dried, then photographed and analyzed under consistent conditions. The consistent methodology will give a uniform, detailed, and digital archive over properties and minerals. We believe this sequence will be used in future projects as a standard analysis program for exploration wells.

Since sample material is limited, the project decided to introduce additional, destructive analyse (QemScan, SpecCam, TOC and XRD) only for a critical mass of data, which was defined to be 5% of the project wells (75 wells). It will give a certain contraction of data for further evaluation of the need of different studies on the sample material.
This data in a digital form will be uploaded to the Norwegian National Data Repository for Petroleum data (DISKOS) and available to the public. Such a vast database will create an efficient way to allow for "Big data" analysis and give the fundament for integration within a whole range of disciplines.

GeoScience Advisor – An AI-based System for Subsurface Characterization

E. Vital Brazil[1], R. Ferreira[1], V. Silva[1], L. Martins[1], C. Raoni[1], R. Cerqueira[1], A. Fernandez[2], J. Almeida[2], S. Fernandes[2], B.F. Carbalho[2], J. Casacão[2], C. Libório[2], M. Quintela[2], M. Ramos[2], D. Patrocinio[2], M. Ferraz[2], D.S. Cersósimo[2]
1 IBM Research
2 GALP

Artificial Intelligence (AI) has been successfully adopted in many industries in recent years. The results are encouraging, with AI being able to reduce costs and improve performance in different applications, sometimes outperforming its human counterparts. However, most of current models and technologies are still restricted to specific tasks and cannot be easily adapted to different contexts without a significant effort. Such an ability is especially important for knowledge-intensive tasks such as seismic interpretation, which is heavily dependent on the interpreter's experience and tacit knowledge. Moreover, this dependency makes it challenging for oil companies to deal with interpretation biases and knowledge loss when, for instance, seismic interpreters leave the company.

Since interpretation requires the incorporation of reasoning, experience, and the ability to integrate large sets of quantitative elements, humans have difficulties in finding correlations in high-dimensional spaces and providing quantitative rather than qualitative evidence for their assessments. Seismic interpretation is at the heart of any significant decision regarding acquisition, operation, and development. These decisions generally have a massive impact on the profit, from hundreds of millions to billions of dollars. However, in many cases, the current ability to provide a solid understanding of the components that make up the subsurface is limited, and decisions based on it are sometimes insufficiently grounded.

To tackle these pressing issues, we propose a system that sheds light on the transition from Narrow AI to the so-called Broad AI in subsurface characterization and related decision-making. We combine powerful machine learning models with an efficient knowledge representation and a symbiotic human-AI interface to develop an AI-based GeoScience Advisor (GSA) that assists the analysis of geological information, enhances seismic data interpretation and captures interpretation knowledge. GSA integrates with and augment the existing tools used by geoscientists and interpreters to help them improve subsurface characterization with the support of industry-trained AI algorithms.

GSA uses advanced AI techniques, such as knowledge management, machine learning, information extraction, mixed integer linear programming, and computer vision, as well as machine teaching techniques to identify, represent, store and reuse contextual information for seismic interpretation, which is the essence of the knowledge of an expert interpreter. Decision points typically used by interpreters during the interpretation process are recorded by the system, capturing characteristics identified by the user, causal effects, and properties of seismic volumes. Based on this, AI techniques were applied to improve the efficiency of the seismic interpretation process in exploration and production activities.

The technology developed in this project has been redefining the Exploration work processes adopted by an O&G company, and the initial results indicate a significant increase in productivity in many activities. Our main contributions are:

- A visual comprehension mechanism that integrates machine learning with knowledge graphs, capable of identifying, grouping and characterizing textures, image recovery, structural analysis, and semantic search;
- A Physical Property Characterization (PPC) of rocks is made based on analysis of multi-dimensional seismic attributes, and generalized additive-analytical statistical models that correlate data from wells and seismic reflection, amplified by the geological context;

- A consistency-driven methodology and computational tools for assessing the Level of Knowledge and Probability of Success of an exploratory prospect;
- A mechanism based on knowledge graphs to integrate multiple AI models across multiple workflows and over time;
- An integrated approach for AI explainability and machine teaching that allows the curation of knowledge bases and continuous machine learning;

This work is a first step towards broad AI, and the results obtained so far have shown the system's ability to better manage the corporate knowledge, reduce bias and improve seismic interpretation quality and time requirements. As next steps we intend to investigate technologies and approaches to assist the evolution and curation of the Knowledge Base, as well as the generalization of the approach to other activities in subsurface characterization. We also want to perform more comprehensive experiments to assess the impact of this technology on different E&P workflows, in terms of qualitative/quantitative improvements and time reduction. We believe this technology is posed to change the geoscience landscape, allowing a significant time reduction in performing geological analyses, improving reliability, capturing expertise, retaining knowledge, defining new workflows and exchanging processed information.

Session Two: Advances in Wellsite Technology

Wellsite gases…Old Dog, New Tricks?

Tim Dodd and Julian Moore
Applied Petroleum Technology

Wellsite mudgas compositions have been gathered on all wells since at least the 1950s, and data have been digitally recorded from about the 1980s. Prior to the advent of LWD this was the go-to data set for the first definition of pay zones and what might be the expected reservoir fluids. The data were also extensively used as a pore pressure interpretation tool.

Since the advent of LWD, this data source has fallen somewhat out of favour along, with its old buddy of shows analysis.

With the advent of more reliable and consistent methods of measurements at the rig site, coupled with the more or less full petrophysical data coverage of overburden and pay section in all wells, perhaps the time is ripe to revisit an old friend.

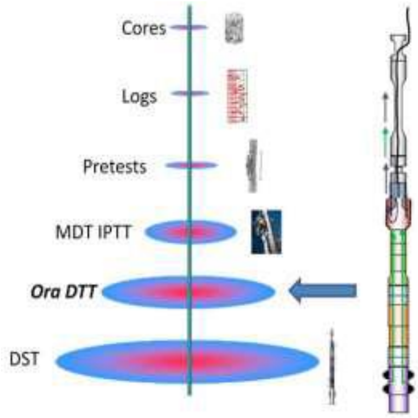
This talk explores some simple methods to define pay from wellsite gases, and looks at some methods to define the nature of the fluids in the pay discovered. It also folds in some of the newer insights from the integration of isotope data into wellsite gas evaluation. We will also look at example where gas data can be used to make an estimate of the pore pressure profile of a well drilled in the central North Sea.

You might not see much new, but we hope what you see shows that this is an underused source of information that gives a good interpretation of pay and doesn’t require you to spend hours justifying that expensive logging run.

Tech Byte: ORA Fluid Acquisition and Deep Transient Testing (Repsol case studies offshore Mexico)

Karl Perez, Alejandro Martin, Ricard Fernandez[1] Francois Dubost[2]
[1]*Repsol Exploration*
[2]*Reservoir Domain Champion Schlumberger*

In Q1 and Q2 2020, Repsol performed an exploration drilling campaign in offshore Mexico. Due to the situational oil price, there was an even greater need to perform efficient formation evaluation, in order to make quick, accurate, and reliable decisions. Repsol made the decision of running the latest generation tool on the market, ORA, that combines the best characteristics of several traditional tools. With ORA, Repsol and Schlumberger were able, for the first time, to obtain real time contextual insights, perform a numerical analysis of the ORA DTT and test and sample unconsolidated reservoir sands and relatively heavy oils. ORA allowed Repsol to achieve acceptable results that traditional probes would not have provided, inprovided, in more timely and efficient way.



In previous projects, Repsol utilized radial probes, focused probes or dual packer, either independently or commingled. ORA tool compiles all the technological advantages and qualities from each of these tools into one single string.

In the same campaign, a new wireline formation testing technique known as Deep Transient Testing (DTT) was also performed. DTT combines high resolution measurements, high flow rates and longer test durations to perform transient tests in higher permeability, thicker formations and at greater depth of investigation than with previously formation testers. The platform combines advanced metrology with extensive automation to generate unique, real-time reservoir insights.

Traditionally, pressure transient analysis and well deliverability predictions were produced through an analytical framework. Today, DTT measurements are interpreted and placed in reservoir context in real-time and directly incorporated into geological and reservoir models. The products obtained, including reservoir fluid compressibility, saturation pressure, EOS models, well productivity or minimum connected volumes are integrated remotely in real-time utilizing numerical analysis. The key reservoir insights are shared among all stakeholders in a collaborative environment for both operational control and rapid decision making.

In conclusion, in very low consolidated formations, ORA or MDT on cable can provide information for ORA DTT filter selection before TLC run to avoid issues, save rigtime and ensure reliable results. In Repsol's 2020 Mexico campaign, the fluid samples retrieved with ORA proven to be high quality and the transient test was successful, with few difficulties.

Tech Byte: How to get accurate formation temperatures in a post mercury world

Chris Wells
AccSensum Ltd

Formation temperature is a critical, yet elusive subsurface property to measure. Some of the key needs for subsurface formation temperature include:

- Well construction and completion material selection
- Reservoir production management
- Petrophysical Log corrections
- Cement Design
- Evaluation of Fractures
- Basin Model calibration
- Geothermal energy estimation
- Understanding basin hydrodynamics

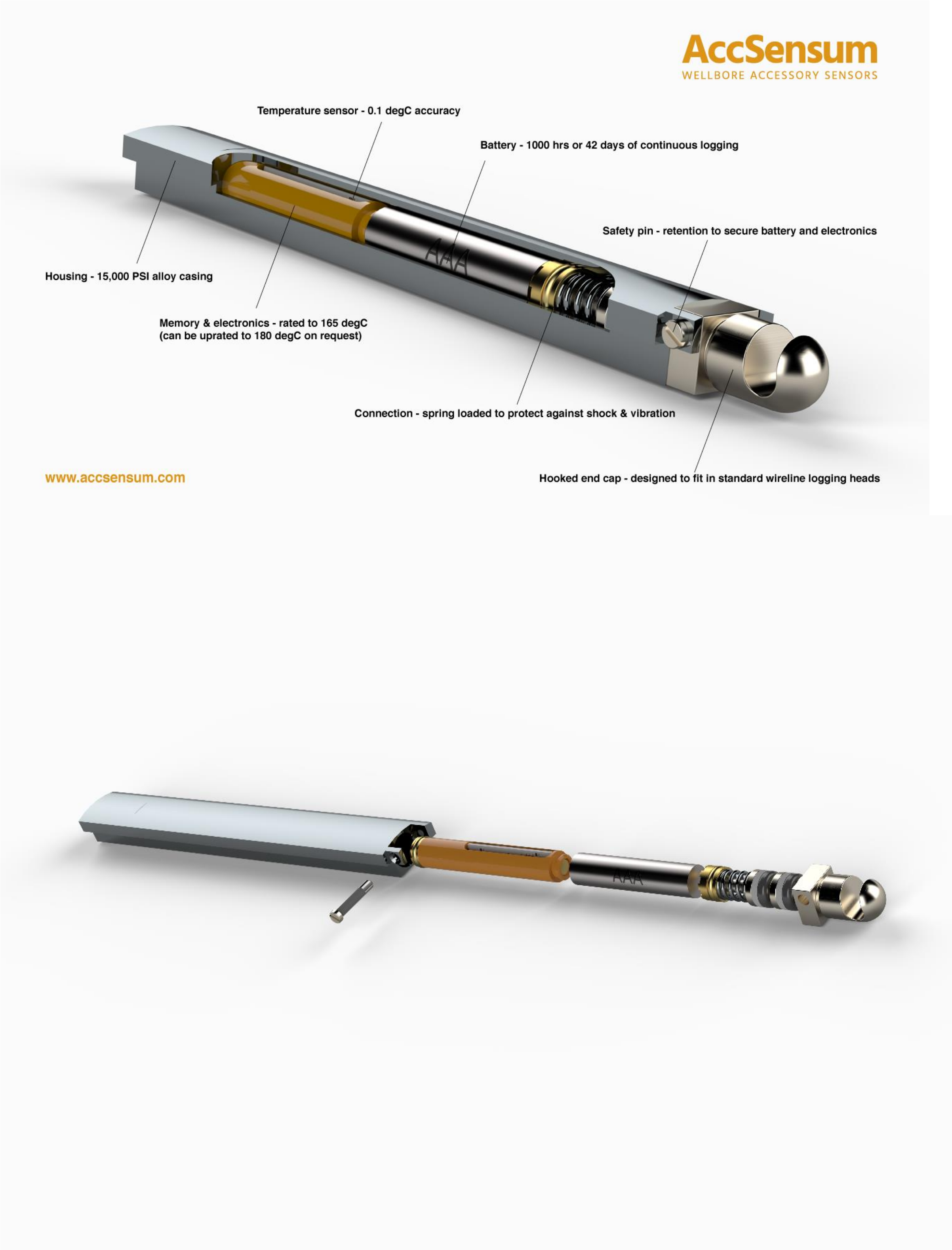
Due to cooling effects of drilling mud, temperature measurements taken soon after a well is drilled are generally lower than formation temperature and pose a real challenge to providing accurate formation temperature estimates.

The most robust way of estimating virgin formation temperature is to either flow the well sufficiently long enough that near well bore cooling effects are overcome. Alternatively a tried and tested methodology is to perform a Horner estimate of virgin formation temperature using temperature measurements taken in the wellbore at different times after drilling stops. The Horner method, plots the measured temperature (at a given depth) from each of several logging runs, against log(T/(t+T)), where T is the time since circulation of the drilling fluid was stopped, and t is the length of time of circulation of drilling fluid prior to this.

Traditionally, the inputs used for the Horner Plot method were provided using mercury based maximum reading thermometers. However, this is no longer a viable option due to the HSE risks that Mercury in these thermometers present, resulting in the banning of sale and export of such devices in key global markets. There are competing technologies available to try and overcome this challenge each with different challenges and merit.

This presentation will provide an overview of the various temperature measurement devices in use today with a focus on the T-1000 memory thermometer solution (Figure 1). The T-1000 provides a consistent, accurate and efficient way of not only getting maximum temperature measurements from all logging runs, but also a time based continuous temperature measurement, allowing for accurate Horner corrected formation temperature estimates.

Figure 1 - The T-1000 Memory Thermometer



An enhanced approach implying a pre-drill modelling to improve real-time drilling operation in complex environments using integrated disciplines and technologies

Ehsan Daneshvar[1], Timothy Pearce[2], John Martin[2], Roger Burgess[3]
[1]*Future geoscience Ltd.*
[2]*Chemostrat Ltd.*
[3]*PetroStrat Ltd.*

Recently it has been reported that a couple of international companies have undertaken drilling of development wells in order to access new reservoirs offshore Malaysia. One of the most challenging times in a real-time drilling operation would be a situation where a target reservoir is located within a structurally complex stacked sections while there are also problems with well completion and logging while drilling (LWD). In such cases, the accuracy of LWD logging, the prediction and estimation of the location of reservoir(s), recognition of overlain and underlain layers, all need further cautious detailed analysis. A pre-drill model for drilling such situation is brought to attention to control (decrease) the costs and reduce the impacts on environment. To understand the situation, a simplified but real situation has been considered. It is basically assumed that (1) two formations X and Y are stacked vertically, (2) formations comprise mudstone and sandstone respectively with a transitional boundaries between them, (3) there is a fault zone in the section and (4) biostratigraphy is inconclusive due to barren strata.

In this paper, the advantages of a pre-drill scheme and benefits of applying Chemostratigraphy and mineralogy together with a time series log analysis are discussed. As a scenario, the X Formation is likely to be identified in real-time using LWD gamma ray logs together by elemental analysis of the drilled cuttings. Utilising the gamma ray and changes in chemical signature (elements) provide an earlier indication of the formation top, allowing for better control of the actual footage drilled into the formation. The X Formation is expected to be approximately 100 ft thick at this location. Drilling to a section TD approximately 70 ft into the X Formation will allow for the shoe to be set approximately 30 - 50ft into the formation. It is expected that the last 20 ft of the X Formation is changing transitionally to Y Formation. The prognosis for the Y Formation has a 50 ft uncertainty, which is within and close to the base of the prognosed X Formation and through Y Formation too. Therefore, there is uncertainties on placing the shoe well into the X Formation, without drilling too close to the prognosed shallowest depth of the Y Formation. However, in the case where the Y Formation is encountered shallow, the likelihood is that the overlying transition zone and X Formations will also be encountered shallow to prognosis. Section TD will therefore be recognised, as confirmed by LWD logs, and elemental analysis on drilled cuttings. Reporting top of the Formations, transitional layers, and TD, all need a moderate to high confidence level. In summary all those aspects are necessary to confirm the position of the targeted reservoir, and shoe well placement. Section TD will be picked by the Wellsite Geologist after all and confirmed by the Ops Geologist.

To mitigate the risk of the LWD instability, reducing the negative impacts on environment, and offer a very cost-effective workflow, an analytical pre-drill to real-time drilling workflow model has been developed. This enhanced approach is based on (1) review and (2) new analysis on off-set wells using different techniques including time series log analysis (INPEFA), elemental data analysis (chemostratigraphy) and Fourier-Transform Infrared Spectroscopy (FTIR) analysis. As a result of the pre-drill set of analysis on the off-set wells, this runs a better understanding of the separate reservoirs, matching logging results and lithology and optimisation of the completion plan. The pre-drill part of the project has been developed in order to update the workflow for the LWD, and applied stratigraphy analysis in real-time drilling (in complex and fault zones). In addition to those advantages, a live correlation panel between off-set wells and drilling well can be updated regularly in real-time drilling.

FTIR results significantly helped us to discriminate minerals with similar elemental compartments whereas they represent different lithology. The elemental values and ratios applied to reconstruct the depositional environment. INPEFA results can develop the modification patterns in log analysis.

Tech Byte: Displaying Well Control Incident Data in Petrel; a Workflow for Promoting Rig Safety Across Disciplines

Kurt Armbruster

Rig safety begins in the office. Well control incidents such as kicks and blowouts can be catastrophic. Kicks are commonly controlled, however, in the last 40 years in British Columbia, 16 out of 894 (1.7%) of the well control incidents reported to the BC Oil and Gas Commission (OGC) have resulted in blowouts. In the worst cases, these can lead to loss of rigs or loss of life.

On the Engineering side of well planning, it is a common practice in the Oil and Gas industry to mitigate the risk of kicks and blowouts by preparing Pore Pressure and Fracture Gradient (PPFG) predictions prior to drilling the well. The PPFG process should include a tabulation of any lost circulation, kick, and blowout incidents. PPFG data are ultimately used to provide a window for the mud weights while drilling, and may dictate additional casing runs.

This paper will demonstrate one Petrel workflow in which a Geologist can contribute to the safety culture of the rig crew. By preparing a simplified cross section depicting the precise stratigraphic location of well control incidents and posting the cross section in the doghouse, OSR shack, or wellsite geologist shack, the author intends to empower rig crews to anticipate zones which may be problematic. With annotated cross sections, rig workers will be able to see a visualization of offset well control incidents in stratigraphic space, in addition to the tabular format generated during the PPFG process. For best results, the geologist should collaborate with their drilling and reservoir engineers during the entire well planning process.

This paper utilizes BC data in Petrel as a case study. The workflow may be applied to any basin in which well control incident data are available. Some data/map vendors in Canada include well-incident data in their mapping services, and allows a user to post the data on maps, and cross sections. Call your data/mapping package provider for details. If your mapping and cross section software has the data included, use this methodology to import data into Petrel, or use your preferred software to supply maps and cross sections to field personnel.
Continued: https://www.linkedin.com/pulse/displaying-well-control-incident-data-petrel-workflow-kurt/

Day Two

Tech Byte: An Objective Skills Assessment for Operations Geoscience

Christine Telford, Tim Herrett, Bob Fagg and Martin Gardner.
OGICA LLP.

Inspired by positive feedback and mandate from previous Operations Geoscience conferences in 2014, 2016 and 2018 OGICA (Operations Geoscience International Competency Assessment) have now developed and launched an objective skills self-assessment for all working operationally in upstream oil & gas geoscience. A robust question database created together with our experienced industry specialists and peers is accessed via an online software platform supplied by a leading IT provider of online training and assessment.

The tool allows operations geoscientists across the energy sector, to objectively assess their current skill levels. At the conclusion of the assessment a visual output is generated with a 'digital badge' which can be uploaded for sharing their results online. Together as a benchmark of skill levels it also highlights skill gaps where individuals may wish to address for further experience or training as part of their career CPD.

The system offers a cost effective, anytime self-assessment for operational geoscientists around the world, enabling them to demonstrate the skills they have. It has also been identified for use as a first stage in operator and service company competency assessment and it could also form a universal first stage for use in competency programmes in the consultant operations geoscience community.

Session Three: New Workflows for Well Planning & QA/QC

Top-hole geohazard and rig-site surveys: fit-for-purpose, cost effective, neither, or both?

Francis Andrew Buckley
Independent

Rig site survey and top-hole geohazard reporting is a safety-critical aspect of well-planning, however acquisition and reporting of site survey data has become separated from the main activities of exploration and drilling. Apart from a few exceptions, where operators maintain their own survey departments, responsibility for ensuring that the requirements of national HSE regulations, international 'best practice', due-diligence and under-writers' stipulations on survey input to well-planning, may be delegated to a variety of departments or personnel within operator organisations. In either case, the work is then sub-contracted, with or without the assistance of a dedicated survey consultant, to a specialist contractor, whereby data are acquired, processed, interpreted and reported by the contractor, validated and technically assured by the consultant and ultimately accepted by the operator.

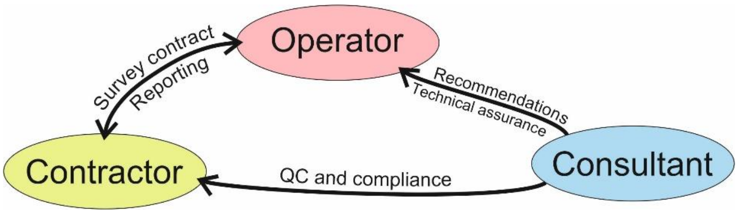


Figure 1: Contractor/Consultant/Operator relationships

This process has changed very little since the early 1980's, but in some respects it is deeply flawed. In the first instance the survey contractors' business model is predicated on survey operations, such that most of the planning, management and day-to-day communications are dedicated to marine data acquisition at sea: for every £million spent by operators on site surveys, 95% of it goes on data operations, with only a small percentage spent on data interpretation and reporting. This is a perverse state of affairs, as only the conclusions of the survey report are required by well-planners, the acquired survey data having no commercial value. The cost of all operational, weather down-time and other external interference factors is borne by the operator, who is not guaranteed to receive a full, interpretable dataset at the end of the process. It is even the case that a vessel may spend several weeks at sea and collect no usable data, although this is admittedly a rare occurrence.

Data interpretation and reporting are carried out over highly restricted time scales by teams often lacking the resources necessary to perform anything more than a rudimentary interpretation of the data. Given that environment, survey reporting has evolved into a standardised product, dominated by routine workflows, a few key conclusions and limited risk mitigation advice on hazard avoidance. In general this process does not address complex or nuanced scenarios where simple avoidance is either not possible, not desirable or ineffective.
More complete interpretations of the data, including techniques which are in routine use in exploration have been shown to be effective tools in top-hole risk mitigation. These include AVO studies, EEI studies complex attribute analysis, seismic inversion, synthetic modelling, fluid substitution etc., but they are largely precluded by time and budget considerations, the skill sets of interpretation teams and the lack of applicable software.

The conclusion is that dedicated site surveys do not represent value for money and might not be fit for purpose. Whose fault is it?

- The survey contractors: As professional organisations they ought to be promoting technical excellence, innovation and best practice. In effect they prefer the status quo whereby they are assured an income based on limited vessel availability and a dependable proportion of weather down-time

- The survey consultants: They should be advising their clients on cost-effective solutions to top-hole drilling risk mitigation, including alternatives to dedicated site survey data acquisition. Unfortunately the main survey consultancies are tied into the same business model which underpins the survey contractors and are therefore under the same pressures to deliver acceptable profit margins to their respective share-holders.
- The well-planning community: The owners and drivers of the entire workflow who are acutely aware of the consequences of failure to deliver a fit-for-purpose risk mitigation strategy. It is sometimes the case however that survey considerations are not addressed until well-planning is in a mature stage when it may be halted owing to the unforeseen consequences of complex survey data interpretations.
- The operators (and their accounting departments): The buck stops here and it is the responsibility of operators to ensure that geohazard and rig-site surveys are both cost effective and fit-for-purpose.

How can the situation be remedied?

Over-reliance on acquisition of dedicated HR2D seismic data is at the heart of the problem. If operators could ensure that exploration data acquisition encompassed top-hole, as well as over-burden and prospect exploration requirements, the most weather dependent aspect of site surveys would be removed. Seismic broadband acquisition and processing innovations are capable of replacing outdated HR2D datasets with comprehensive 3D data that are by-products of deeper exploration. Freeing site survey vessels from the necessity of acquiring HR2D data would enable simple seabed survey data to be acquired by a more diverse assemblage of contractors and vessels, including large construction and dive support vessels which, though vastly more expensive, could complete surveys within a fraction of the time, especially when combined with AUV and ROV technology.

A thorough integration of geohazard specialists onto well-planning teams at the inception of drilling projects would ensure that top-hole risk mitigations could be itemised and prioritised at an early stage. Licensing and delivery of multi-client seismic data and/or re-processing of in-house data, followed by detailed interpretation, could proceed in the absence of any formal site survey planning. Any requirements for dedicated data acquisition would then be informed by a priori knowledge of sub-surface geology, fluid migration and pressure regimes. The corporate Client/Contractor/Consultant relationship could be re-envisaged in terms of data and deliverables, as illustrated below.

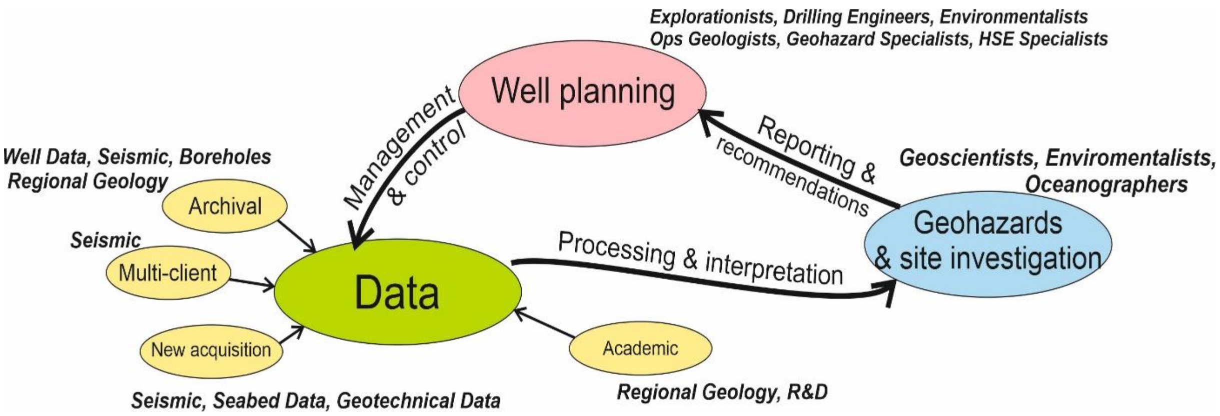


Figure 2: Data processing and reporting relationships

The obvious casualty of such a re-organisation is the survey contractors' business model. But, given the safety critical nature of top-hole risk mitigation, alternative working practices may be required for the prevention of catastrophic well incidents.

Operations Geology: Logging QA/QC, integration within drilling and data acquisition workflow

Rodney Garrard[1], Serge Marnat[2]
[1]The National Cooperative for the Disposal of Radioactive Waste (Nagra), Switzerland
[2]Geneva Petroleum Consultants International

For the safe disposal of radioactive waste, the geothermal industry and the oil and gas industry, a detailed quantification and characterization of the mineral and fluid content is of key importance. The Operations Geologist roles include but are not limited to optimization of the data acquisition, whilst ensuring the project objectives are met within the allowed budget. We will see in the following examples the importance of integration of the whole workflow by the Operations Geologist, from borehole design through log acquisition to petrophysical and geomechanical interpretation.

In Nagra's deep borehole project (TBO), the main potential host formation for radioactive waste disposal is the clay-rich Jurassic Opalinus Clay. It must be ensured there is no probability of any interaction with the nuclear storage in the long-term, that might compromise their structural integrity. It is essential therefore, to acquire high quality petrophysical data to provide a detailed compositional breakdown of the host lithologies. In particular, the clay content, clay typing and porosity evaluation in the Opalinus Clay will drive the disposal strategy. The ongoing drilling campaign comprises several boreholes, the first one was Bülach1-1 (BUL1-1). This borehole was drilled with a low salinity water-based mud (WBM), which resulted in large washouts in the shaly formations, making a good quality wireline log acquisition impossible.

The lesson learned was that the initial mud formulation did not facilitate the wireline data acquisition. Clay inhibitors (potassium, K-silicate mud) were successfully added to the mud system in the latest boreholes, providing an in-gauge hole allowing for good data acquisition. However, introducing potassium into the mud has a direct impact on the spectral gamma-ray tool (HNGS) measurement of the thorium, uranium and potassium concentration. The ratios of these elements (e.g. Th/K) are key data for clay minerals quantification. It is therefore imperative to accurately correct for the presence of potassium in the mud system. The integration of the workflow by the Operations Geologist, from borehole design through log acquisition to interpretation, minimized this impact. A high-level, almost real-time QA/QC procedure was implemented. The HNGS output curves (HSGR, HCGR, HFK, HTHO and HURA) were corrected for three different potassium contents: 0% (no K correction), K content from Daily Mud Report (DMR) and K content in mud from HNGS indirect measurements downhole.

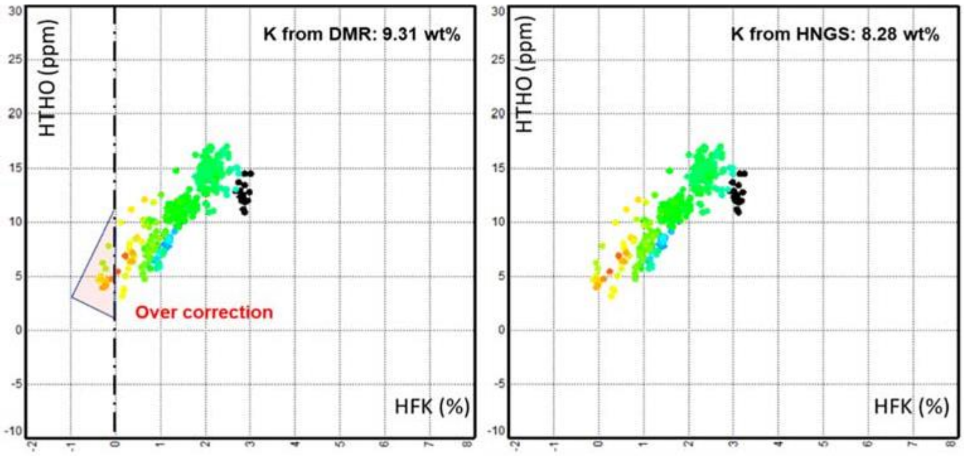


Figure 1 Potassium correction comparison between DMR and HNGS reading in a TBO borehole. The X axis represent the K content from HNGS, the Y axis the Th content from HNGS.

Figure 1 shows an example of the impact of the K-silicate mud correction on the HFK and HTHO curves. A detailed QA/QC ensures provision of the most accurate spectral gamma-ray curves that will be used as input for the multimineral models for clay-typing. Note that, since the K and U peaks in the GR spectrum overlap, the quantification of each element depends on the other, meaning that the U is impacted by the K correction. A second example of the impact of expert QA/QC while running wireline logs is the maximization of the output of the elemental spectroscopy tool ECS (Schlumberger). While the standard ECS processing (WALK2 mainly provides Si, Ca, Fe, S, Al, Ti and Gd, an alternative processing (MGWALK) can additionally evaluate the magnesium content and its uncertainties in low clay content intervals. This requires good communication between the teams, as the logging speed should be reduced to the lower limit of the winch capability for optimum quality. The impact of the MGWALK processing is a better quantification of the dolomite and calcite volumes in complex mineralogical settings (Figure 2):

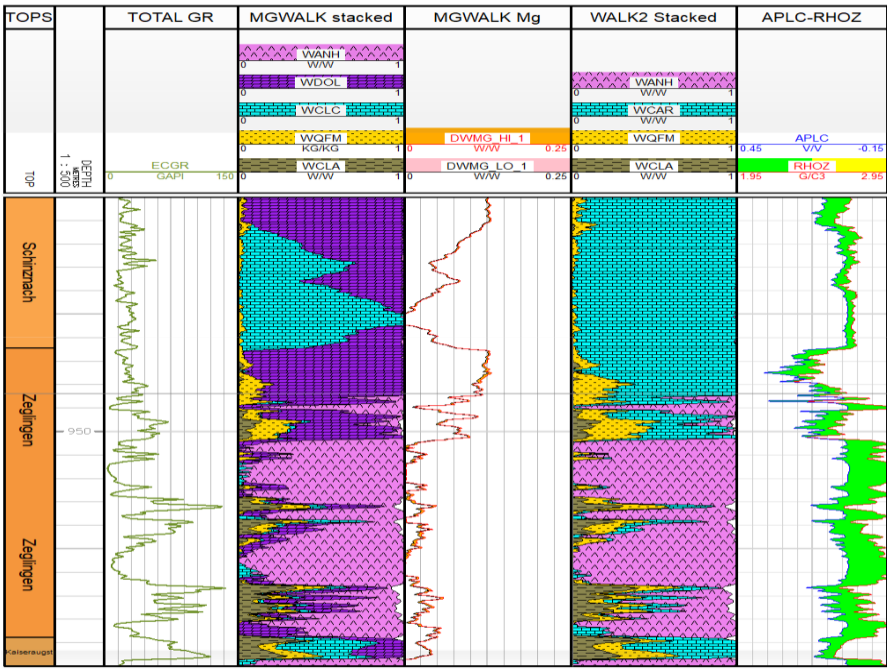


Figure 2 Comparison of standard ECS processing (WALK2) with advanced ECS acquisition and processing (MGWALK)

The integration by the Operations Geologist of the entire workflow, from borehole design to wireline log multimineral interpretation, allowed safe and efficient drilling of the later boreholes, while ensuring the best data quality for host rock evaluation.

The most modern tools and methods must be anchored to a human-based, traditional QA/QC expert approach integrated into the workflow. An increased, integrated focus on QA/QC in realtime will maximize the value of the wireline logging acquisition.

There is a strong incentive to achieve an integrated workflow from borehole design to interpretation through QA/QC to ensure maximum data value.

Tech Byte: Automated Well Control: new technology to improve safety in well control

Bryan Atchison
Safe Influx Ltd

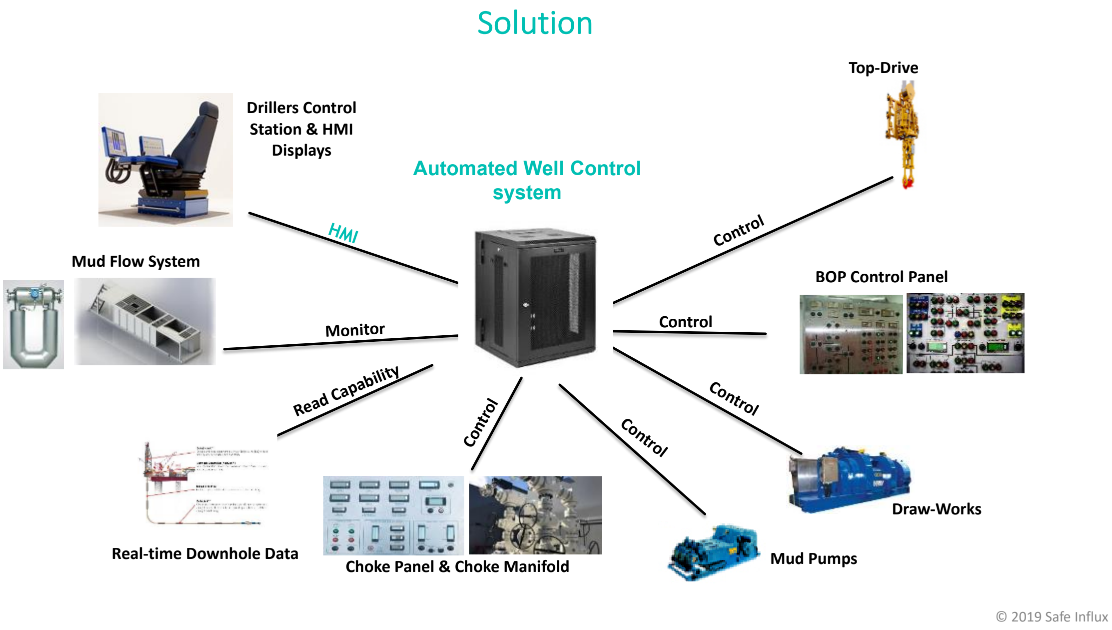
Well Control is the process used to enable safe management of a pressures and fluids encountered whilst drilling through the earth's crust. As a borehole penetrates different geological formations, it can encounter pressure regimes created by geological processes that are not anticipated.

Management of well bore pressures is predominantly controlled by the Primary Barrier, which is the Drilling Fluid and its density. In the event of an unexpected pressure regime is encountered, this is controlled by the Secondary Barrier. The Secondary Barrier is a combination of recognition of the influx, driving the equipment to enable a safe shut in, followed by closing the Blowout Preventer (BOP) equipment. This provides a pressure tight seal at the top of the well. Fluid then flows into the well bore until a natural balance of pressure occurs between the donor formation and the pressure within the well bore. Once the well has stabilised, the drilling teams then formulate a plan to resume operations. Most of the time this involves restoring the Primary Barrier by circulating in a higher density fluid.

The Secondary Barrier is therefore a combination of effective sensors, process safety, human factors, competency in the areas of kick detection, equipment maintenance and operation. Throughout the "Secondary Barrier" process, the key element which is safety critical and extremely time sensitive is recognition. If the influx or kick is not recognised, this can result in an uncontrolled flow of oil and gas from the reservoir to the rig. With an ignition source, the subsequent fuel fed fire can have catastrophic effects on the rig and its operating personnel.

One major oil and gas industry challenge is that well control is entirely reliant on a single human being to detect an influx and safely shut-in the well. It is estimated that up to 67% of blowouts are caused by human factors, according to reports and studies (BSEE 2017). Automation can dramatically reduce the risk of Major Accident Hazards in well construction by almost eliminating the human factors elements that create most of the issues resulting in blowouts. The Automation of Well Control bring a significant step change in the area of Process Safety for wells. It has a potential to prevent blowouts, reduce all influx volumes and potentially reduce kick tolerance volumes reduces casing and well costs. A smaller influx volume results in more well kill options and less time required to resolve the situation before resuming productive operations.

A system has been developed which enables Automated Well Control whilst in drilling mode. Pre-determined influx volumes agreed by operator and drilling contractor and input by the driller are established. Once the system detects the influx, it performs a series of operations by taking control of the drilling rig equipment. The drill string is spaced out, top drive and mud pumps are stopped, and the BOP is closed. All of this occurs without the driller doing anything; however, he can intervene at any moment. This is done with machine code instructions enabling simultaneous commands to be issued and executed. The system is designed as an aid to the driller and does not remove his responsibility.



The Automated Well Control system has been tested into drilling simulators. Additionally, a field trial using a traditional rig demonstrated the effectiveness of the system, proving up the functionality under different operational requirements. Furthermore, a full Technology Qualification process has been used for this technology. The system is currently designed for the drilling phase. However, over 50 potential modules have been identified. Planned developments for the system include circulating out the kick automatically, shut in for tripping, circulating, cementing and in-flow testing.

It is believed that this system will enable a step change in the performance of process safety for well control. If set up properly, the system will react automatically providing a fast, safe and effective shut-in, dramatically reducing Major Accident Hazards, thereby minimising formation damage, saving millions of dollars per well, reducing environmental impact, and preventing loss of life.

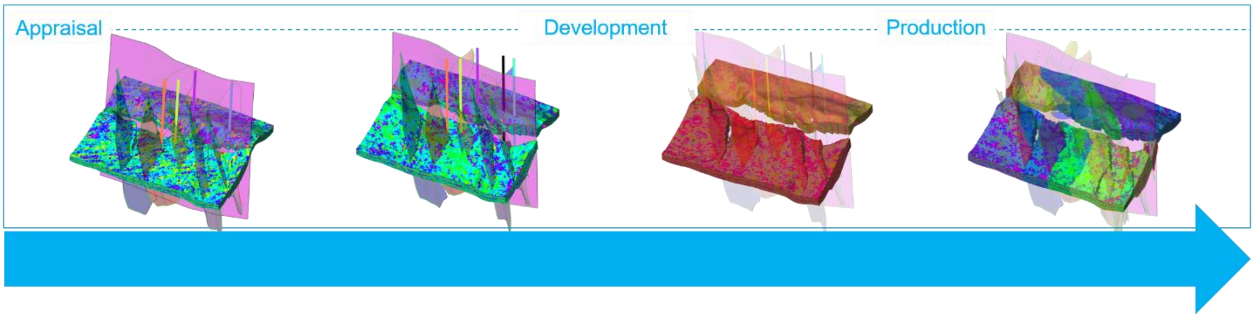
Tech Byte: Digital Solutions are Change Catalysts for Moving Operational Geoscientists from Cooperation to Agile Collaboration: Big Loop as an Exemplar

Camille Cosson
Emerson Automation Solutions

The role of digital transformation can be divided into two: The adoption of new technologies to reduce manual processes and remove inefficiencies; and the adoption of best-in class behaviors to continue improving performance. The decision on the part of companies to make a strategic move and embark upon the digital transformation journey is motivated by the promise of reducing costs while increasing operational successes and ensuring faster return on investment. With a focus on operational geologists, it is often noted how advances in technology can help move toward better success in exploration, faster time to first oil, and more optimized field development and production plans. However, in order to succeed in their digital transformation efforts, E&P companies must adopt both new technologies and new behaviors. In this presentation, the Big Loop™ solution will be presented as a technology that can serve as a catalyst for changing the behavior of asset teams from cooperation to collaboration.

Throughout the life of a field, the insights used to make strategic decisions are based on cooperation between highly skilled specialists doing jobs serially but separately. As a result, silos develop between the domains, as each has its own language, methods and technologies. Cooperation is not collaboration. Collaboration is about connecting the specialists to ensure that they listen to one another, take an interest in what the other team is doing, bring their own expertise to a problem, and have a stake in providing a comprehensive solution to an overall problem. To achieve success with such a transformation, managers must encourage their asset teams to communicate on multiple levels. This is dependent on team management, but also on technology.

Big Loop is offered as a system for integrating and automating G&G workflows with reservoir engineering, to improve reservoir risk assessment and field plan optimization. The Big Loop technology has been deployed at different scales, in different customized formats within numerous E&P companies. It provides evergreen models and robust risk quantification through the generation of multiple models to capture and propagate uncertainties. All the reservoir modeling processes are automated and can be run at will. New data are integrated and propagated forward from geophysics and petrophysics through static and dynamic modeling. Production data captured all along the field's life cycle are assimilated using a machine learning-based assisted history match solution. Not only the dynamic models, but also the static reservoir models as well as any geophysics or petrophysics processes automated in the integrated workflow are calibrated by field data - this is the feedback part of the loop.



Evergreen: The models evolve throughout the field life cycle

In teams where Big Loop has been adopted, specialists have changed their approach to reservoir modeling. The most interesting aspect is how such integration fosters communication and knowledge transfer within the team. Any geoscientist in the asset team can own the workflow. They can leverage the forward and feedback loop to learn more and gain a better understanding of the field features lying within their disciplines. The solution provides a common basis for geoscientists that captures with high fidelity a global understanding of the field across a broad range of disciplines. Team members can test and learn within their own domain while also measuring the impact of their work on overall results and the relationship with others' jobs. The result is daily communication, both when new data arrives but also whenever new problems or interrogations arise. With Big Loop, operations geoscientists are freed from their single-discipline blinkers. By removing constraints, asset teams begin to work using "agile" collaboration. Agile development relies on teamwork as opposed to individual role assignment. Agile asset management entails autonomous teams of operational geoscientists collaborating on projects. Each expert can deal with a specific aspect of the project, and regular meetings will be held to review the features, from planning to implementation within the reservoir model (their shared basis). The incremental nature of the work leads to much faster turnaround time and closer team collaboration.

It is true that disrupting well-established routines is a challenge. It takes time to adopt new methodologies, but Big Loop's scalability, from a single asset team to all asset teams in an E&P company, makes it easier to deploy. Opening the door to autonomy and collaboration has significant impact on a team's overall performance, but also benefits every individual. It stimulates participation and involvement, and team members care more about their work, leading to greater creativity, closer mutual assistance, and higher productivity and service quality. As explained in this paper, a comprehensive, integrated and automated solution like Big Loop is the key catalyst for initiating this change.

Title: A Descriptive and Predictive Analytics (DAPATM) framework to deliver a step change in performance for wireline and MLWD operations - why only a collaborative approach can drive real improvements in service delivery.

Jack Willis
one&zero

Operational metrics and Key Performance Indicators (KPI) have been a cornerstone in improving operational performance within the oil & gas Industry for decades. Lost Time (LT), Non-Productive Time (NPT) and Mean Time Between Failures (MTBF) are typical metrics which are commonly used to benchmark service delivery and highlight areas of under-performance. Loss prevention and Root Cause Analysis (RCA) methodologies underpin the process of understanding why such issues occur.

This presentation will explore the data which has historically been used to chart losses and seek performance improvements. Using specific examples it will show that, alone, previous approaches to data collection are structurally inadequate for identifying areas of potential performance improvement, and that the data we do have on wireline and M/LWD operations is often underutilized. The presentation will outline how descriptive analytics and predictive analytics together can provide a methodology for improving performance at the wellsite.

Descriptive analytics is a general term for a range of statistical techniques which create a summary of historical data to yield useful information about what has already happened. Within wireline and M/LWD operations there are large swathes of data collected by both operator's and service providers, but often this data is siloed, non-standardised, and not accessible to the decision maker in a form that is useful. Additionally such data is often missing key input variables or contextual pieces of information which are necessary for an operator to make effective decisions on future operational execution. We propose a new data collection structure to begin to resolve such issues.

Predictive analytics seeks to expand this understanding of what has happened in the past, by predicting what may happen in the future. This presentation will propose how the current structure for data collection in relation to wireline and M/LWD operations is not effectively categorized for such analysis. It will briefly explore how a more effective method of collaborative collection can provide a volume of data to feed into a process of predictive data analysis using a variety of statistical techniques to assist in making better planning decisions.
General questions for the audience to consider:

- Can we truly say that the information gleaned from the lessons learned locally, regionally and globally are effectively being utilized in today's planning processes?
- Can we say that wireline or M/LWD BHA design is based on previous successes taking into account all of the key variables that exist?
- Do we effectively use data on past operational performance to predict future operational performance?
- Do we (actively) choose which tools to run-in-hole based on a complete understanding of past performance and history?
- Do we make the same mistakes twice (across the industry)?

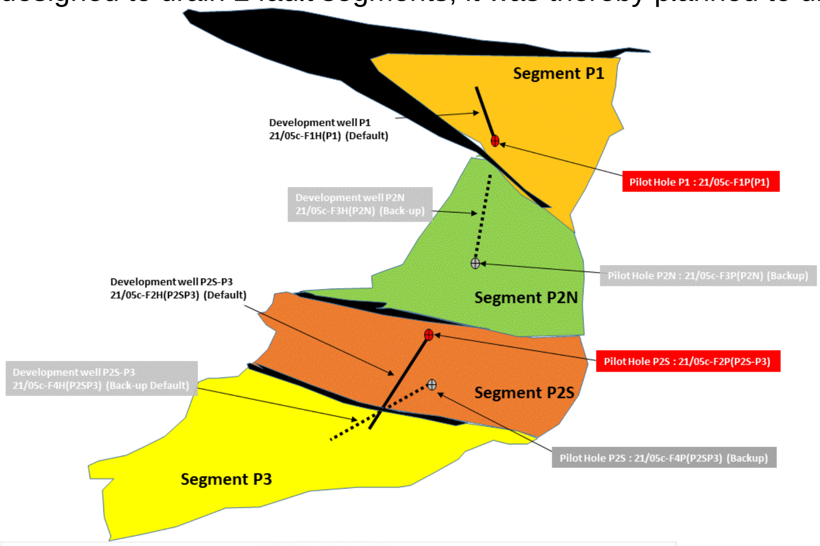
Session Four: Operations Geoscience Case Studies

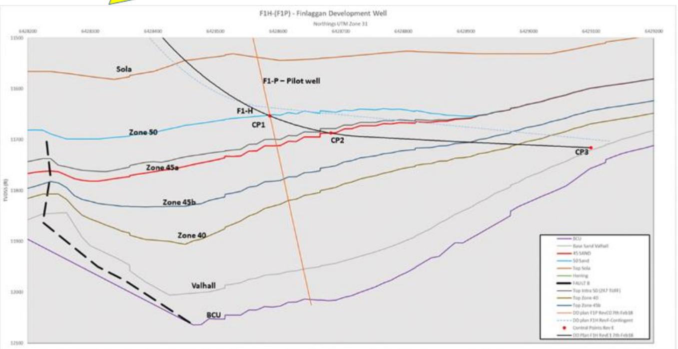
A focused optimized approach to Geological Operations – A Case Study; The Finlaggan Development CNS – Zennor Petroleum 2020

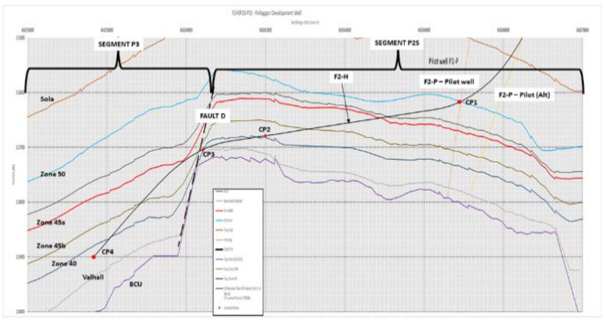
Steve Gear[1], David Baldwin[2], Peter O'Mara
[1]*Zennor Petroleum*
[2]*Baldwin Petrophysical*

The Finlaggan Field, discovered in 2005 was appraised by Zennor Petroleum in 2016 in order to acquire data not collected by the original well campaign. Following a successful outcome of the well and succeeding FID and FDP approval, a two (2) well development was planned for 2019 to optimize production.

The Finlaggan gas condensate accumulation is a complex stratigraphic trap formed by pinchout against an old high of a series Lower Cretaceous Britannia sandstone turbidite reservoirs within three fault segments. The primary goal was drill two strategically placed development wells optimally placed to develop the field, these wells were F1, and F2. Each of the wells would be required to have to intersect all four (4) of the major Britannia sands (Zone 50, 45a, 45b and 40) as well as meet a number of other criteria. The southern well was designed to drain 2 fault segments; it was thereby planned to drill across a fault.







The Key Operational Objectives set for each of the wells were as follows

- Maintain a minimum 100ft stand off above the water contact along the wells entire lateral length.
- The wells were to be geometrically geo-steered to ensure optimal horizontal well path for subsequent production efficiency; notably to avoid sumps.
- Ensure cross cutting of the key reservoir zones (Zone 50, 45, and 40) within each well bore and within each segment penetrated in order to reduce the impact of baffling shales

- Achieve an estimated total kh of at least 35,000 mDft for both producing wells. This requires a sufficient N/G, porosity and permeability in each sand body.

A focused plan was defined to ensure these criteria could be met, allowing operational and technical success in the four KEY following ways:

(A) Firstly; to develop understanding of overlying and interbedded reservoir shales, thereby defining geo-mechanical strength and clay types. This allowed for determination of the appropriate mud type (OBM) to ensure that the well could be drilled optimally whereby maintaining well bore integrity and stability.

(B) Secondarily; definition of KEY “Tools” to determine the stratigraphic position of the wellbore at any time during the operational process – Pre well Biostrat and Chemostrat studies, along with LWD ultra deep resistivity tool modelling (EarthStar).

(C) Thirdly; given the complex nature of the reservoir and structural setting each well required a number of scenarios and trajectory plans to modelled pre-drill in conjunction with the Earthstar tool. This allowed for efficient revision of the plans in response to the ongoing outcome of each well to optimise the wells and achieve the objectives.

(D) Fourthly; team role allocation and communication for the execution phase – use of optimal communication and reporting tools (What-app, well XP, Realtime data, 24hr cover and subject matter experts at the wellsite and with the on-shore operational team)

With a clear and optimized Operationally focused approach to the planning and execution of both Finlaggan wells, Zennor petroleum were able to achieve all well and field objectives, and due to swift real-time decision making and specifically the use of focused high tech LWD tools, were able to stay in the reservoir sections longer, and to have a much higher than expected reservoir coverage and interface with much higher than expected N/G.
Both F1 and F2 wells were cleaned and tested to the maximum allowable flow rates. The wells are expected to go on production through the Britannia production facility mid 2021 producing NET to Zennor approximately 25,000 bbls /day.

The impact of ultra deep resistivity reservoir mapping tools on geosteering from wellsite

Jamie Bevan
Bevan Geological Services Ltd.

Ultra deep resistivity reservoir mapping tools have had a significant impact on how geosteering is approached at wellsite. Examples include GeoSphere by Schlumberger, Visitrak by Baker Hughes and Earthstar by Halliburton. The most powerful currently have a depth of investigation exceeding 250ft. Between 2014 and 2018 I initially gained first hand experience of traditional approaches to geosteering from wellsite on a development in the Danish sector of the North Sea. Schlumberger's GeoSphere tool was introduced as the wells in this development became more complex and I collaborated in changes made to this approach.

During the initial stage of the project, the various chalk reservoir units of the Tor and Ekofisk formations were fingerprinted while landing the wellbore in the reservoir using traditional LWD tools; the density image log in particular, biostratigraphy, quick look porosity and saturation calculations, as well as cuttings samples, and oil and gas shows. From this fingerprinting it was then possible to recognise the target reservoir unit for that particular well and steer the wellbore towards and then within it. Optimum placement was maintained using regular bed dip and thickness calculations from the density image log, porosity and saturation calculations at regular intervals and by receiving regular biostratigraphy updates. All changes in target inclination were noted down chronologically and justified in a spreadsheet. Many of the reservoir units had overlapping expected porosities meaning sub-seismic faulting or sub-optimum geosteering could lead to uncertainty arising regarding which reservoir unit the wellbore was currently placed within.

The most reliable way forward was to pick up the bit off bottom and circulate samples to surface for biostratigraphic analysis. Issues with this approach include the additional rig time required to circulate bottoms up on an extended reach well. In addition, the potential jumbling of fossil assemblages leading to uncertain or multiple biozones being observed by the biostratigraphers. This as a result of cuttings passing through up to 10,000ft + of open hole on route to the surface. The introduction of ultra deep resistivity tools for the latter stages of the development had several positive impacts on how geosteering was approached. The real time resistivity cross section of the reservoir created with the tool gives a larger scale image of the reservoir structure, providing a solid base for discussions with the subsurface team onshore and was especially helpful when explaining steering decisions to colleagues without a geological background. This graphical representation of the reservoir combined with regular distance to reservoir roof calculations from the tool engineers provides wellsite geologists with a greater level of confidence that they are achieving optimum wellbore positioning within the reservoir. This in turn, leads to fewer stops in drilling being required to circulate samples to surface for biostratigraphic analysis to confirm position within the reservoir, saving significantly on rig time. There were also fewer changes in inclination being requested to 'hunt' for a sweet spot or target reservoir unit resulting in smoother well trajectories that remained easier to drill at respectable ROPs for greater footage.

Challenges in using these tools included, the need to properly integrate additional service engineers into the team so that the agreed chains of communication were fully understood and followed to ensure that there was no confusion and that everyone was kept up to date with the current steering objectives. It was also important to guard against the tendency of people becoming over reliant on the one tool, this as they are not without limitations. In situations where the objective was to place the wellbore within 20ft of the reservoir roof there was still the risk of being thrown up out of the reservoir by sub-seismic faulting, though the tool can often provide an accurate measurement of the faults throw once drilled through, which in turn can aid in planning open hole sidetracks. It is also not always possible to differentiate between each of the different reservoir units using resistivity alone. A particular reservoir unit was often the target for each well in this development meaning, proper fingerprinting of the units during reservoir landing was still vital.

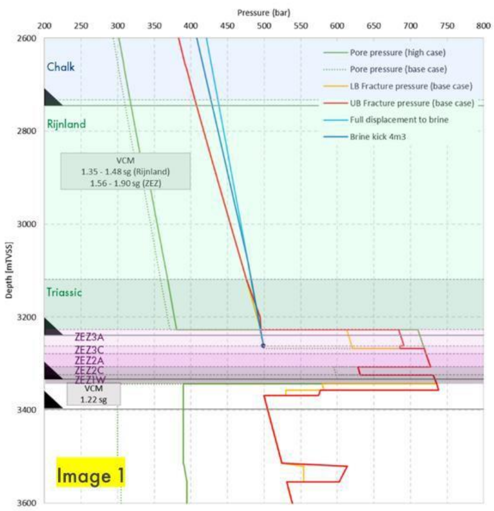
The risk of tool failure is also always a possibility when drilling particularly long hole sections/ extended reach wells, so it is important to remain capable of continuing to TD without a particular tool wherever possible to avoid costly tripping time.

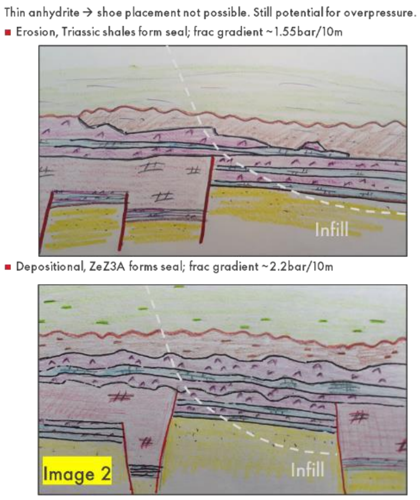
In conclusion, the use of ultra deep resistivity is a powerful tool when geosteering from wellsite which greatly aids both, optimum wellbore placement and reduction of rig time required to drill an extended reservoir section. I found this to be best achieved when it is used as an important tool amongst a suite of tools alongside tried and tested geosteering techniques.

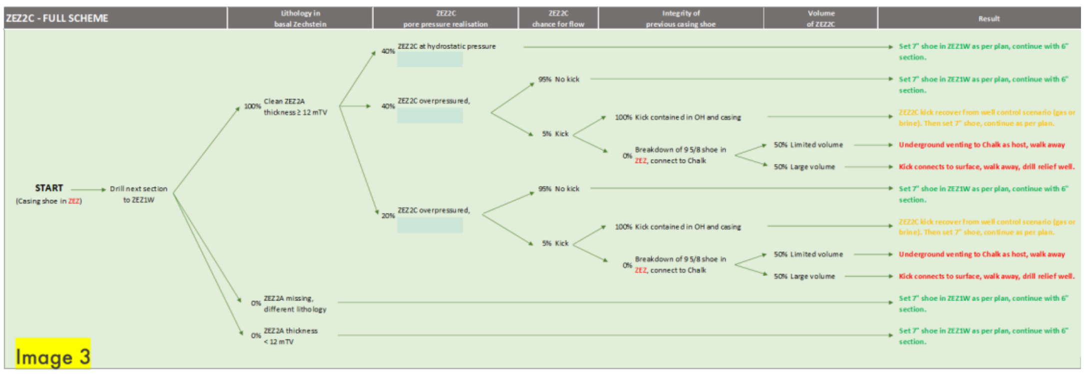
Multi scenario modelling and risk-based approach for a challenging well planning at Southern North Sea through complex Zechstein configuration

Kumar Satyam Das, Geoscientist, Shell Netherlands

Numerous wells have been drilled through the Zechstein the Southern North Sea has helped to understand the Zechstein formation over time. Despite this, there are few local variations which result in complexities in well planning. The present study involved the planning of an offshore horizontal well into a producing tight gas field. This field consists of three existing wells (two exploration and one development well) and the present well is an accelerator well. A top Zechstein casing shoe is required for kick tolerance (image 1). By integrating log data, mudlog, seismic, it was concluded that multiple scenarios are possible for top Zechstein configuration ranging from no Zechstein to thin Zechstein and moderately thick Zechstein (image 2). Each of these affected casing shoe placements. To tackle this uncertainty (thickness uncertainty and shoe placement), multiple scenario models (based on seismic forward modelling and offset well data) were prepared. These robust results were conveyed to the DRB through a simple decision tree (image 3) elucidating uncertainty and its effect. This work was appreciated for clear communication about the complex geological and drilling uncertainty through robust quantification.







Wellsite and Operations Geologists remote workflows and duties during COVID-19 pandemic

Alejandro Martin, Karl Perez
Repsol Exploration

Due to the COVID-19 pandemic in 2020, operations and wellsite geologists faced new issues in their daily jobs during Repsol's drilling operations in Mexico and Bolivia, in which there was a lot of international employees/contractors, and borders were being closed. The traditional workflows and routines had to be adapted and modified in order to manage the risks associated with the situation and improve the safety without jeopardizing the operations.

Firstly, Repsol implemented a 14 days quarantine protocol for the wellsite geologists and service providers before going to the rig site. Because of that, instead of having two wellsite geologists to cover both day and night shift, at some point there was just one at the rig site as the rotations were affected. The other wellsite geologist performed some of the tasks remotely from town, such as daily geological report generation, etc. In the future the wellsite geologist working remotely from town will be able to examine cuttings in real time through pictures or videoconference, being in close communication with the mudlogging crew.

Regarding the operations geologists working in town, Repsol banned all the business travels and implemented teleworking from home, so all the daily tasks were performed remotely. For example, the QAQC of the wireline logging tools in the provider's base was supervised remotely through videocall. In the past the operations geologists used to travel to the wellsite to supervise the wireline logging operations. In this case, supervision was also performed remotely through WebEx by two operations geologists working two hours shifts from two different places Mexico City and Madrid, so they covered the 24 without any disruptions. They were in constant communication with the wireline engineer at the rig and the domain champion from the service provider in town. Ultimately, technology enabled Repsol operations and wellsite geologists to adapt and change some of the work routines during the pandemic. The company will keep moving forward in order to achieve our objectives in a safely and timely manner, without implying any kind of disruption for the drilling, logging and testing operations.

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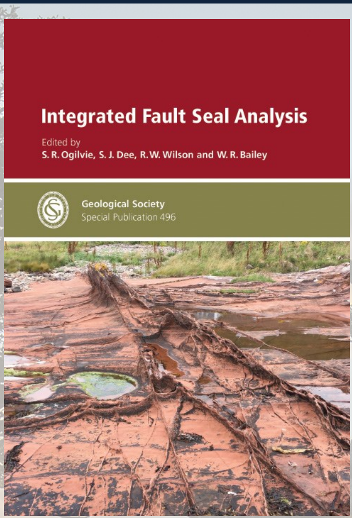

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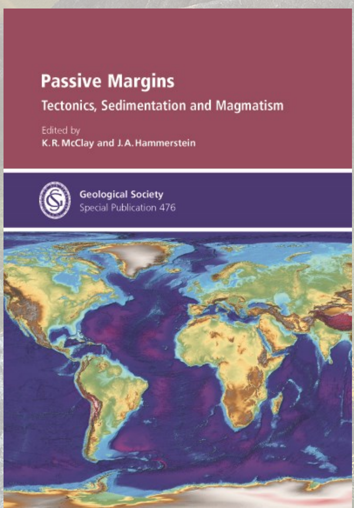

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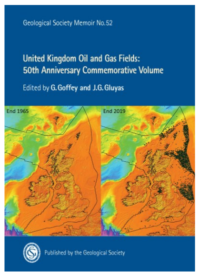
Dates for your diary

MEMOIR 52 LAUNCH CONFERENCE: UK OIL AND GAS FIELDS 50TH ANNIVERSARY COMMEMORATIVE MEMOIR

Date: 30 November 2020
Venue: Online

Buy Memoir 52

For updates and to register see the event page



PROSPEX 2020

Date: 15th - 16th December 2020
Venue: Online

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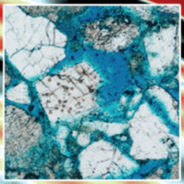
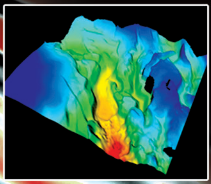
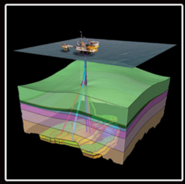

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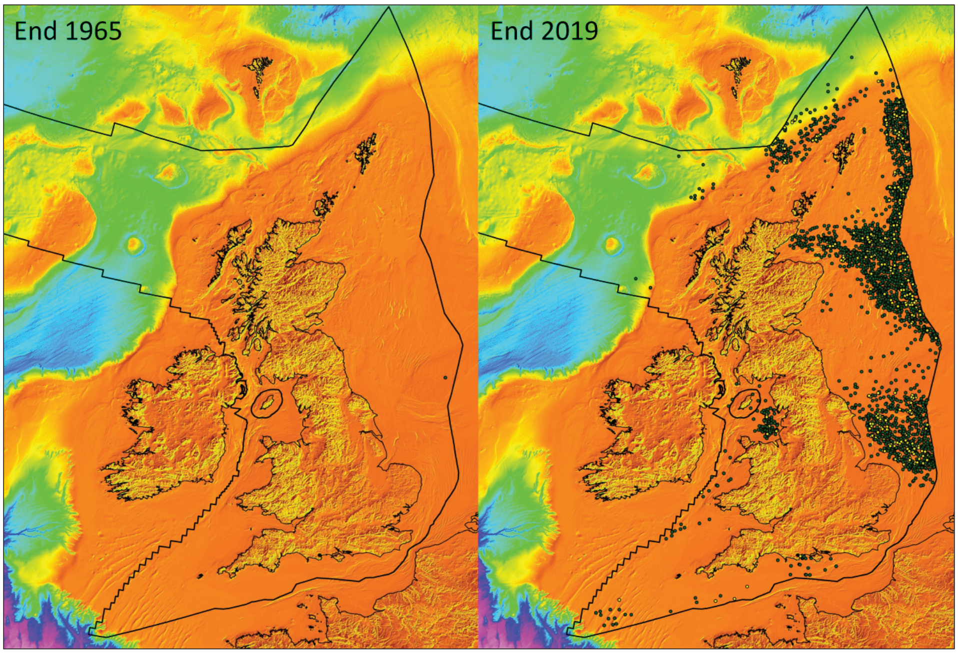
LAUNCH CONFERENCE – MEMOIR 52

UK Oil and Gas Fields

50th Anniversary Commemorative Memoir

30 November 2020

Virtual Conference



Geological Society Memoir 52 records the extraordinary 50+ year journey that has led to the development of some 458 oil and gas fields on the UKCS. It follows the 1991 and 2003 Memoirs and is the largest of the series, containing papers on around 150 fields both on and offshore. Memoir 52 is a major, landmark volume that will be an enduring data source for those exploring for, developing, producing hydrocarbons and sequestering CO2 on the UKCS in the coming decades.

This conference marks the publication of Memoir 52 in Q3 2020. Sixteen invited speakers will discuss fields which are contained in the Memoir. These talks will cover all of the major UK basins and will highlight themes which run through the Memoir. These themes include the utility of seismic data across the value chain, evolution in drilling and completion technologies, recent and near term field developments, and new exploration targets in less common reservoirs and subtle traps. As such it will be of benefit to all geoscientists working the UKCS.

For further information or to register please contact:

Sarah Woodcock, sarah.woodcock@geolsoc.org.uk
Web: https://www.geolsoc.org.uk/11-rescheduled-memoir-52-launch-conference-2020

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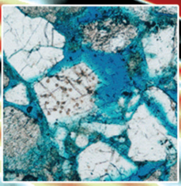

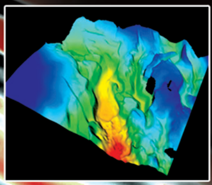

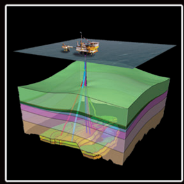

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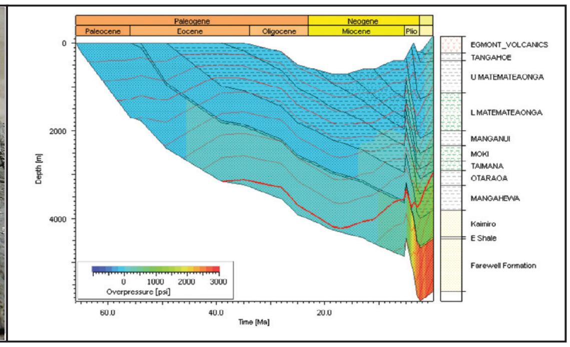
Confirmed New Date

Geopressure 2021

Managing Uncertainty in Geopressure by Integrating Geoscience and Engineering

23-26 March 2021

Virtual Conference and Masterclass



The organisers invite contributions within any aspect of geopressure but are particularly interested in the various phases of pore fluid pressure prediction, modelling and overpressure evaluation to manage uncertainty during the life cycle of a well. Suggested themes and sessions include:

- Pore Pressure and stress, especially complex stress regimes
- Impact of machine learning on PPFG
- Well engineering and PPFG
- Injecting fluids underground (including CO2)
- Coupling of Pore Pressure and FG including depletion and closing the drilling window
- Seal capacity and relationship with PPFG
- PPFG issues in mature basins (including abandonment/decommissioning)
- Classic case studies, including Macondo and LUSI mud volcano
- Pore pressure as an exploration and prospectivity tool.
- Geopressure in mature basins – lessons learnt
- Pore pressure in active tectonic basins
- Unconventional stress regimes

Event Details:

23-25 March 2021: Conferece

26 March 2021: Best practice for PP and FG - Mastery Class - Led by Richard Swarbick

Further Information:

For more information please contact sarah.woodcock@geolsoc.org.uk or visit the event website: https://www.geolsoc.org.uk/03-rescheduled-pg-geopressure-2021

Organising Committee:

Stuart Jones
Durham University

Nick Pierpoint
NWP Geoconsulting

Richard Swarbrick
Swarbrick GeoPressure Consultancy Limited and Durham University

Scientific Programme Coordinators:

Toby Harrold
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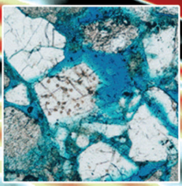
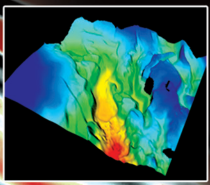
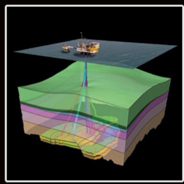

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Anton Padin
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Keynote Speakers:

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Manchester University

Patricio Desjardins
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Confirmed New Date

Core Values: the Role of Core in 21st Century Reservoir Characterisation

3-7 May 2021

Virtual Conference

Reynolds and Krevor 2015

Core has traditionally played a key role in the characterisation of conventional and unconventional hydrocarbon reservoirs, from exploration to mature production. It is the only means by which to observe and make measurements on actual reservoir rock. However, the recent oil industry downturn has driven many to question the value of taking core, due to the associated increased costs and potential risks to well operations. In tandem, advances in other reservoir visualisation techniques, such as seismic and borehole imaging, have been used to give weight to the contention that coring is an increasingly redundant means of characterising reservoirs.

Through four main themes this 5-day conference will aim to redress the balance in this debate by exploring the role core can, or should, play in the 21st century exploration to production cycle:

- Is core critical to sound commercial decision making?
- What are the challenges and benefits of integrating core-derived understanding across the geological, petrophysical and engineering spectrum?
- Integration of traditional core characterisation methods with new core, well and reservoir visualisation and mapping technologies - is the sum greater than its parts?
- How can the extensive network of global legacy core collections best be utilised to maximise their business and research worth?

For further information:

For more information, please contact Sarah Woodcock, sarah.woodcock@geolsoc.org.uk or visit the conference website: https://www.geolsoc.org.uk/05-rescheduled-pg-core-values-2021

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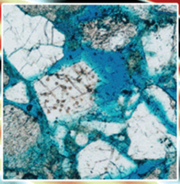
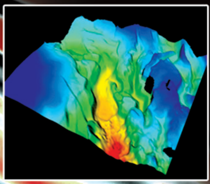
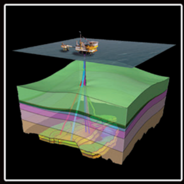

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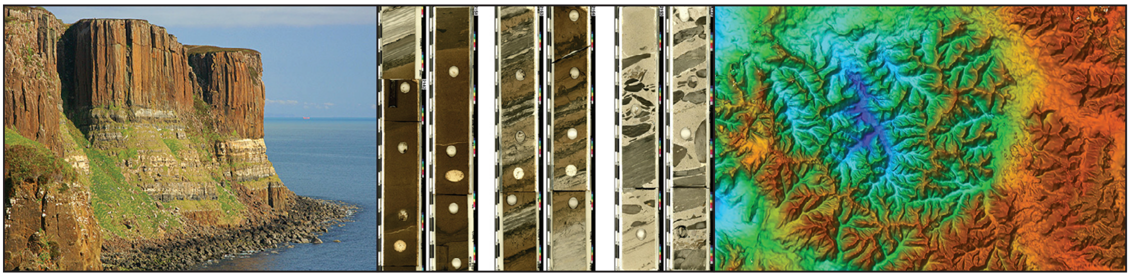
Confirmed New Date

New learning from exploration and development in the UKCS Atlantic Margin

19 - 21 May 2021

Virtual Conference



The UK Atlantic margin, including the West of Shetlands area, is the location of the UK's largest remaining hydrocarbon reserves, the largest recent field development inve tments and holds the greatest potential for future material discoveries in the UK.

In the 10 years since the last Geological Society conference on this region, great advances have been made in the understanding of its diverse plays, from fractured basement to Eocene coastal deposits, and everything in between.

This three day meeting gives a unique opportunity to learn about the geoscience of recent discoveries and field developments, as well as how technology is developing to eet the imaging and drilling challenges of the area. For a fully immersive experience, there is an opportunity to see the diverse range of reservoirs in outcrop on the Isle of Skye (13-17 May 21) and in core at the Iron Mountain facility at Dyce (18 May 21).

Conference themes:

- Paleocene deep water reservoirs
- Mesozoic pre-, syn-, and post-rift plays
- Palaeozoic play (e.g. Carboniferous and Devonian at the Clair field
- Non-clastic plays (e.g. fractured basement, volcanics, carbonates)
- Paleocene-Eocene volcanic-associated reservoirs
- Extra-UK Atlantic Margin
- Multidisciplinary technology session (e.g. advances in drilling techniques, sub-sill imaging, EOR)
- Geodynamics, basin modelling, thermal and uplift/ subsidence history, migration routes
- What's next? The next 10 years for exploration and development in the region.

For further information please contact:

Sarah Woodcock, The Geological Society, Burlington House, Piccadilly, London W1J 0BG. Email: sarah.woodcock@geolsoc.org.uk

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