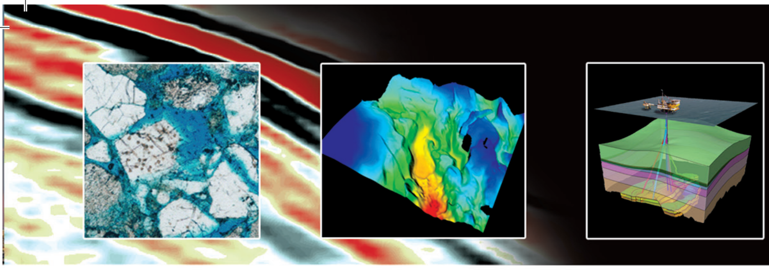

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Operations Geoscience Adding Value

7-8 November 2018

The Geological Society, Burlington House, Piccadilly, London

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PROGRAMME AND ABSTRACT VOLUME

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Operations Geoscience 'Adding Value'

7 - 8 November 2018

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Operations Geoscience Conference: 'Adding Value'

7-8 November 2018

The Petroleum Group
The Geological Society, Burlington House, London

Welcome to the 2018 Operations Geoscience conference supported by the Petroleum Group of the Geological Society. The committee would like to express their appreciation for the Petroleum Group's sponsorship and support of the event. We are also extremely grateful for the additional sponsorship provided by a number of companies, the names of whom can be found on the cover of this abstract book.

Many of you may have noticed that the conference title has been modified from 'Operations Geology' to 'Operations Geoscience', this was in recognition of the contributions from multiple disciplines in this field, and the need for individuals to hold skills that span across disciplines. The aims and themes remain consistent with previous conferences, recognising the pivotal role of Operations Geoscientists.

This conference has been 24 months in the making, and during that time we have witnessed a great deal of change in our industry with the oil price rising from c.$54/bbl to $75-80/bbl at time of writing. This change has been reflected in a slow and gradual recovery of the industry, which although certainly not over has meant a welcome return to work and more stability for many. Special attention has been placed on the value Operations Geoscientists bring to all aspects of the life cycle of a well and the focus on value is even more important under the current, constantly evolving economic climate. This year we have also emphasised the importance of developing non-technical and personal leadership skills throughout (e.g. communication, relationship building, influencing others etc.).

Continuing with a popular theme from the last conference the convening committee wanted to hear from the Wellsite Geology community to better understand the state of the discipline and how it has changed over time. A survey was commissioned, and the results will be presented both orally and as a poster set. Closely linked to this topic is a change from the normal (presentation based) format to a facilitated, open debate on the past, present and future direction of this vital role.

One of the themes this year is 'Formation Pressure and Geomechanics' which has been strongly requested on feedback forms for the last two conferences.

The success of any conference is entirely dependent on the dedication and enthusiasm of the speakers and poster presenters. The committee would like to take this opportunity to extend our tremendous gratitude to our contributors for their abstracts, presentations and posters. We would also like to thank all of you for supporting the conference through your attendance without which none of this would have been possible!

Finally, as with our predecessor conferences, this has been put together by a band of volunteers. If you are interested in helping to plan the next conference in 2020 then please indicate so on the conference feedback form.

Richard Diggens (Chair)
On behalf of the Conference Convening Committee.

Tim Herrett, *Independent* – Co-Chair
Chris Samson, *Independent* - Secretary
Hozefa Godhrawala, *Spirit Energy*
Chris Hayes, *RPS*
Rachael Horton, *BP*
Maxim Kotenev, *Sasol*
Christine Telford, *Independent*

PROGRAMME

CONFERENCE PROGRAMME

Day One	
09.00	**Registration**
09.25	**Welcome**
	Session One A: Value from Self-knowledge (Co-chair C. Hayes & H. Godhrawala)
09.30	**Keynote: Personal Leadership in Operations Geoscience** **Stuart Pidgeon, *Delta Partnerships Ltd***
10.05	**Results of the 2017 Wellsite Geology Survey** Tim Herrett, *Tim Herrett Ltd*
10.30	**Operational Geoscience – towards professional recognition: A progress report and then some…** Christine Telford & Pat Spicer, *UKOGCI*
10.55	**Coffee Break**
	Session One B: Value of Learning Lessons Well (Co-chair C. Hayes & H. Godhrawala)
11.25	**Raiders of the Lost Mud: The geology behind drilling incidents within the Balder Formation around the Corona Ridge, West of Shetland** Douglas Watson, *University of Aberdeen*
11.50	**Qualifying salt as a barrier for well abandonment – A novel P&A approach from the Southern North Sea, United Kingdom** David Dangfa, *Spirit Energy*
12.15	**Real time pore pressure interpretation from drilling events - A case study from high pressure offshore exploratory well** Souvik Sen *Geologix*
12.40	**Poster Session – 5 minutes per candidate (2 speakers)**
12.50	**Lunch** **(Sponsored by RPS)** RPS
	Session Two: Formation Pressure and Geomechanics (Co-chair C. Samson & R. Horton)
13.50	**Video**
13.55	**Challenges in pressure predictions and communications with operations/drilling** Richard Swarbrick, *Geopressure Consultancy Ltd*
14.20	**Geomechanics and geopressures 101– Basic concepts and the link between academia and industry** Gerardo Gaitan, Royal Holloway, *University of London*
14.45	**Maximizing the Potentials of Petrophysical Rock Properties in Deep Formation Pressure Analyses** Kingsley Nwozor, *Chukwuemeka Odumegwu Ojukwu University*
15.10	**Coffee Break (Co-chair C. Samson & R. Horton)**
15.40	**Overpressure Transfer through Interconnected Igneous Intrusions: A New Mechanism for Overpressure Development in Sedimentary Basins** Nick Schofield, *University of Aberdeen*

16.05	**Integrated Risk Management Approach Improves Drilling Performance in Complex Geological Settings** Sanjeev Bordoloi, *Baker Hughes*
16.30	**A case study of the Mckee-13 blowout, Taranaki Basin, New Zealand** Sean O'Neill, *University of Durham*
16.55	**End of day summary (Christine Telford)**
17.05	**Finish followed by Wine Reception in the lower Library** **(Sponsored by Stag and HRH)**
19.00	**Conference Dinner, Cavendish Hotel (Additional Charge)**

Day Two

09.00	**Registration**
09.25	**Welcome**
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09.30	**Keynote: If learning is so useful, why don't we do it? Psychological and organisational insights into the challenges of collective learning** **Kristina Lauche, *Nijmegen School of Management – Radboud University***
10.05	**Well S-33 Well Control Incident in Southern Oman: Causes and Outcome** Hilal Shabibi
10.30	**A complete gas-risking workflow for top-hole drilling studies** Francis Buckley, *Lloyd's Register Survey*
10.55	**Coffee Break (Co-chair T. Herrett & R. Horton)**
11.25	**Fast Paced Learning in a High Activity Onshore Tight Gas Field** Mike McTeague, *BP*
11.50	**SNS Well Abandonments – 4 years on** Christopher Grieve, *ConocoPhillips*
12.15	**Poster Session – 5 minutes per candidate (3 speakers)**
12.40	**Lunch** **(Sponsored by RPS)**
12.55	**Session Four: The Value of Managing and Interpreting Data (Co-chair C. Hayes & H. Godhrawala)**
	Video
13.55	**Geosteering with a bigger torch: infill drilling results using Extra Deep Azimuthal Resistivity (EDAR) from Captain 13/22a-C63 / C63Z** **Jenny Windress, *Chevron***
14.00	**Oil-Base Mud Filtrate and Hydrogen IndexEffects on Magnetic Resonance Porosity in Gas Reservoirs** Stanley Oifoghe, *GPE – Geosciences Baker Hughes, a GE company*
14.25	**How advanced gas analysis provided the last piece of the puzzle to optimise production in one of Europe's classic gas fields** Mariël Reitsma, *HRH Geology*
14.45	**Coffee Break (Co-chair C. Hayes & H. Godhrawala)**
15.10	**Keeping Your Distance: Training Geologists Remotely** Gary Nichols, *RPS Group*

15.45	**Panel Discussion *Past, Present & Future*** - Christine Telford, *Independent* - Marcus Bawdon, *Independent* - Jon Watts, *HRH*
16.10	**End of day summary (Christine Telford)**
17.00	**Finish**

Poster Programme

In Focus: Building Workforce Competency Linda Steedman, *eCom*
A cost effective approach to pore pressure detection using RT methods, a case study: verification of pre-drill model with onsite observations Rudolf Knezevic, *OMV E&P*
Lessons learned on salt drilling in the Campos Basin Pre-salt projects and the importance of the geological knowledge of the salt Munir Pinto Koosah, *Petrobras*
Delivery, consumption and inherent value of classic Daily Reports in a modern drilling operation Colin Maxwell, *Geologix*
Zennor and the art of supplier governance Jack Willis, *one&zero*
Results of the Wellsite Geology Survey (and 2015 Operations Geology Survey) Tim Herrett
Operational Geoscience – towards professional recognition: A progress report and then some… Christine Telford & Pat Spicer, *UKOGCI*

Oral Presentation Abstracts (Presentation order)

Day One:
Session One A: Value from Self-Knowledge

KEYNOTE: Personal Leadership in Operations Geoscience

Stuart Pidgeon,
Delta Partnership Ltd

The 2015 survey of Operations Geologists and the 2017 survey of Wellsite Geologists both highlighted the importance of "Personal Leadership Skills" to the effectiveness of Operations Geoscientists.

But what do we mean by "Personal Leadership Skills"? How do we develop these skills? More importantly, how do we use these skills in our roles to become more effective and add more value?

As with driving a car, most people would say their communication and interpersonal skills are above average, yet as with any normal distribution we know there will be as many below average as above. How do we know how well our personal leadership skills are perceived by others, and in which areas we could focus for greatest value-add?

Many organisations in our industry offer development in both technical and non-technical areas (though not always when the oil price is low!). However many technical professionals choose to invest in their technical development, at the expense of their personal leadership development, despite the importance of the latter.

In this interactive session we will look at these questions, ground the discussion in a little organisational and leadership theory and share some successful examples of development within the industry. We will explore a few options for participants to invest in the development of Personal Leadership skills as an organisational intervention or at the individual level, and encourage participants to get started during the conference!

NOTES:

Results of the 2017 Wellsite Geology Survey

Tim Herrett,
Tim Herrett Ltd.

Following on from the successful survey of operations geologists in 2015, the results of which were presented at the 2016 Operational Geoscience conference, a decision was made to conduct a survey of wellsite geologists for presentation at the 2018 conference.

The survey, conducted anonymously using a commercial online website, attempted to answer some fundamental questions and, additionally, to either confirm or dispel a number of preconceived ideas about the discipline with some hard data. Just what is the role of the modern wellsite geologist? How is the job changing? How has the downturn from 2014 onwards affected the community in terms of work and remuneration?

A total of 285 responses were received from 47 countries around the world. Of those 162 fully completed what was a fairly long and detailed set of questions. The data confirmed how wide ranging and technically challenging the role is but that digital communications are removing some of the decision making away from the wellsite. As with the operations geology survey, it was found that personal leadership skills ("soft skills") were judged to be as equally important as technical skills by the respondents.

The oil industry recession of 2014/15 which is still ongoing at the time of writing in 2018, had a large impact on many of the respondents. A considerable number have had no, or much reduced, work and those that have managed to keep working have seen average remuneration fall by over 30%. This has had an impact on future career paths with over 50% of respondents either getting out of or thinking of leaving the industry if things don't improve.

It is hoped that the results of the survey will make management and contract decision makers better informed and aware of the important role that the wellsite geologist performs in the execution of a well.

(N.B. This is a preliminary abstract which will be edited once more analyses of the survey results have been performed.)

NOTES:

Operational Geoscience – towards professional recognition: A progress report and then some…

Christine Telford, Pat Spicer, Bob Fagg, David Harrison, Martin Gardner, Richard Smout and Tim Herrett
UKOGC.

How do you know you are competent to practice your profession? How do you know that the other professionals you work with on your project or work alongside are competent to play their part? Operations geoscientists work closely on safety critical well design with engineers yet engineers are required to verify their competency via regular certification. Can we rely on supply chain management (SCM) processes to select contractors based on competence rather than just price? In a recent survey, 25% of psychotherapists put themselves in the top 10 per cent of performers and none placed themselves below average. One thing that probably underpins this self-evidently misguided view is the process of assessment was entirely subjective. Just an opinion. None had data to support their view.

Inspired by the impassioned discussions at both the 2012 and 2014 conferences and with a mandate from those at the 2014 event UKOGC has, since September 2015, been working to take forward the idea that Operational Geoscience should be organised into a recognised profession open to all practitioners, generalist and specialist alike, with an objective assessment of competency at its heart. Objectivity adds value in giving practitioner, service or operating company and SCM a consistent measure of competency.

This is a major culture change in our industry, even if the pattern of professional development and assessment we are seeking to deliver is well established and accepted in many other industries. Particularly in safety critical functions. But more than mere professionalisation and competence assessment, our goal is to institutionalise learning in our domain. Eleanor Roosevelt is quoted as saying “Learn from the mistakes of others. You can't live long enough to make them all yourself”. Institutionalised learning is what characterises high performance industries, the lack of it can have horrific consequences.

Progress has been made and we have engaged extensively with all the major stakeholder groups, with varying success. Our presentation will provide an outline of where we are today, where we are headed and why.

It will go further still and in the second half provide a demonstration, with audience participation, of the prototype of a cost-effective competency assessment system.

NOTES:

Day One:
Session One B: Value of Learning Lessons Well

Raiders of the Lost Mud: The geology behind drilling incidents within the Balder Formation around the Corona Ridge, West of Shetland

Douglas Watson[1], Nick Schofield[1], Alistair Maguire[2], Christine Telford[3], Niall Mark[1], Stuart Archer[4], & Jonathon Hardman[1]

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[3] CTC Geo Ltd, 176 Portland Road, Jesmond, Newcastle Upon Tyne, NE2 1DJ

[4] Maersk Olie og Gas AS, Esplanaden 50, DK-1263 Copenhagen Ø, Denmark

The Faroe Shetland Basin, NE Atlantic continental margin, hosts a number of important hydrocarbon fields, though deep water and narrow weather windows mean drilling costs are considerably higher than other parts of the UK Continental Shelf. Any additional drilling complications are therefore important to predict and negate as such issues can result in avoidable multi-million pound cost implications. This study focuses on the Corona Ridge, an intra-basinal high which contains the Rosebank Field, where a plethora of drilling issues are common within a key stratigraphic marker known as the Balder Formation. Bit balling, pack-offs, mud losses and wellbore ballooning are all recognised within the Balder Formation along the Corona Ridge. These drilling events appear to occur in a chain-reaction (Fig.1, below). We find that many of the drilling incidents can be traced back to both the lithological character of the Balder Formation, and the mid-Miocene tectonic inversion of the Corona Ridge. Moreover, we find that this geological explanation has wider implications for exploration in the region, including mitigation of drilling incidents in future wells and the recognition of breached fluid barriers which may otherwise have trapped commercial quantities of hydrocarbons.

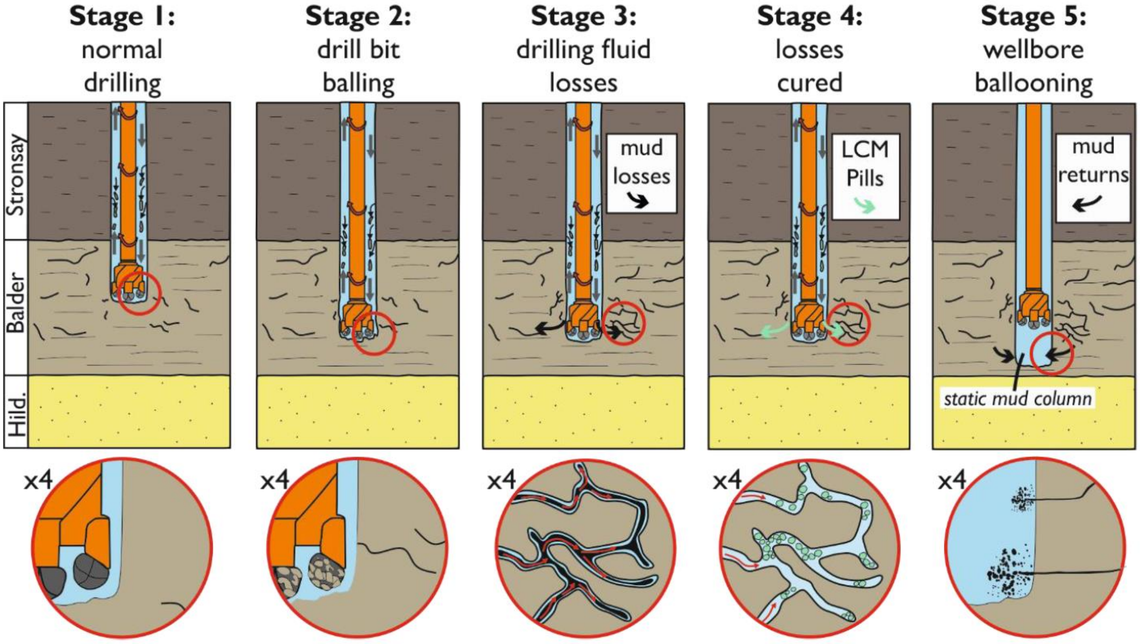

Fig. 1. Chain-reaction of drilling events- including bit balling, mud losses and wellbore ballooning- which occur through the Balder Formation around the Corona Ridge area, West of Shetland.

NOTES:

Qualifying salt as a barrier for well abandonment – A novel P&A approach from the Southern North Sea, United Kingdom.

David Dangfa[1], Hozefa Godhrawala[1], Rashid Sharafutdinov[1], Kamaljeet Singh[2], David Small[2]
[1]*Spirit Energy*
[2]*Schlumberger*

At the end of a production field's life cycle, it is mandatory to abandon the wells. The aim of any abandonment is to avoid any future integrity issues, such as escape of hydrocarbons to surface. Appropriate barriers (mechanical or natural) are required across various sections from reservoir to overburden to abandon wells in a safe manner. In some cases, expensive and time-consuming operations such as perf-wash and/or section milling may be required to restore barrier integrity.

Many studies and tests have been done to understand if salt can act as a barrier. This paper will share the methods and techniques used to evaluate the behaviour of salt around the casing and its capability to act as a natural barrier for plug and abandonment.

The Zechstein supergroup is a late Permian evaporite and carbonate complex. It comprises of five major sequences (Z5 to Z1). The depositional cycle is influenced by increasing salinity through evaporation, following an initial marine incursion. The carbonates are mainly deposited in the Z1-Z3 units whilst the potash and Halite salts are deposited in the later sequence. Halokinesis in the Z2 & Z3 sequence further introduces rafts in the normal Zechstein succession. This process of halokinesis or rafting causes salt withdrawal and gravitational sliding leading to high pressure brine accumulation in the carbonates of the Z3 units. This inherent property of salt to act as a creep agent forms an excellent source of natural bond or seal behind casing.

As part of the evaluation criteria, the historical well records on drilling and cementing activities were studied in relation to the geology. Based on well review, it was decided to acquire data using advanced wireline tool that records acoustic impedance, flexural attenuation, CBL and VDL simultaneously. Various zones were identified from the data that were likely to provide the required isolation. The isolating zone criteria were based on annular solids behaviour, no channels and vertical length of at least 15ft.

The advanced wireline log measurements provided insight on the range of values to expect for acoustic impedance, flexural attenuation, CBL and VDL across salt intervals (figure 1). The pressure test performed by perforating small intervals post logging confirmed annulus integrity and specifically the capability of salt to act an abandonment barrier. As a result, further remedial work was avoided, reducing total abandonment cost. One well has been successfully abandoned as part of this project.

There are hundreds of wells in the Southern North Sea that are lined up for abandonment. A number of these wells cut through long Zechstein salt zone. The technique described in this paper highlights the use of advanced wireline logs to qualify salt as an annular barrier.

This paper brings knowledge on the process of self-healing sealing formations. The abundance of the Zechstein formation in many North Sea fields provides an alternative and cost effective option to be considered for permanent abandonment.

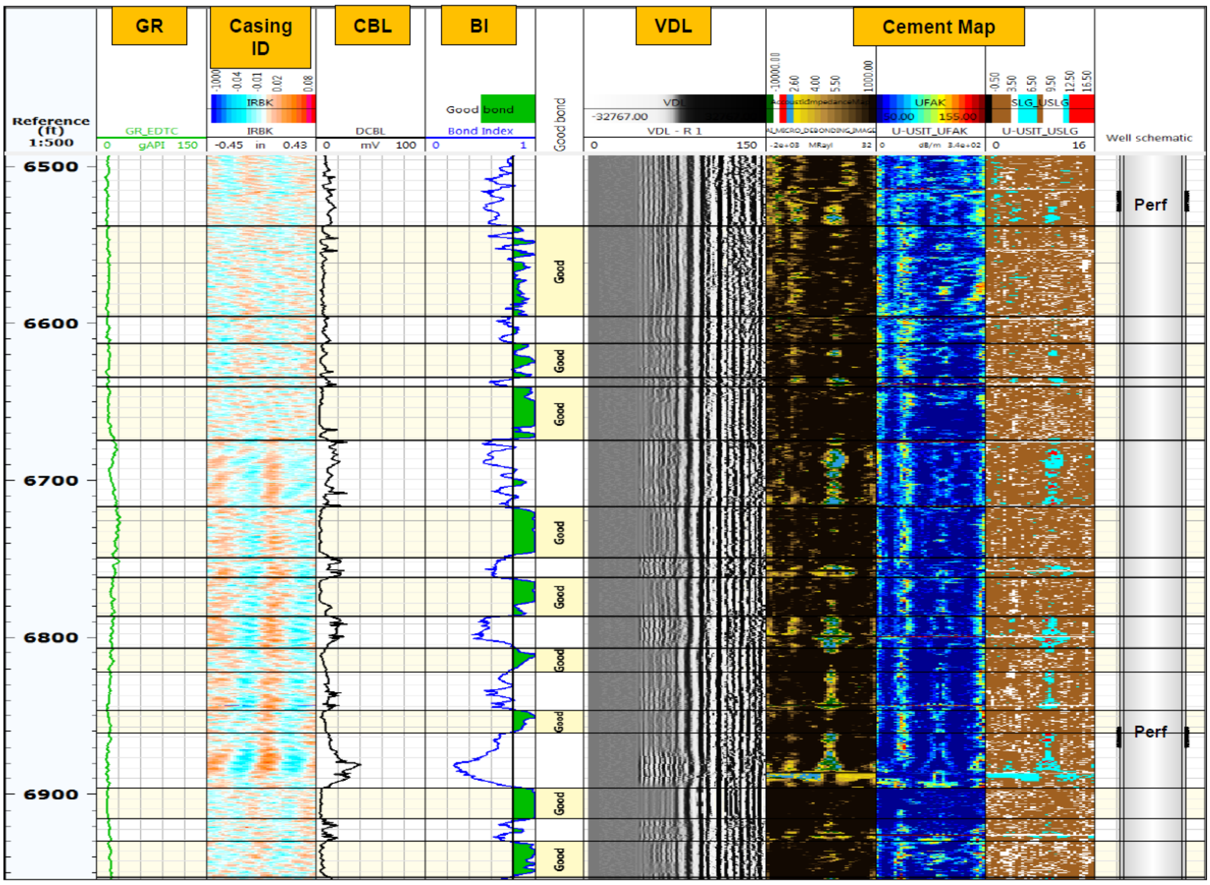

Figure 1: Log data showing the annular material characterisation based on CBL- VDL, acoustic impedance and flexural attenuation. The good bond intervals were identified which were used to position the drillstring BHA for perf-test. The interval between the two black marks (on the completion – last track) was tested successfully.

NOTES:

Real time pore pressure interpretation from drilling events - A case study from high pressure offshore exploratory well

Souvik Sen[1], Mithilesh Kumar[1], Colin Maxwell[2]
[1] *Geologix Limited, Mumbai, India*
[2] *Geologix Limited, Norwich, UK*

Accurate knowledge of pore pressure and magnitudes of principal stress components are fundamental to any safe and economic well construction. Since E&P activities focus more on difficult environments and reduced of drilling cost, pore pressure analysis has become an integral part of well planning and drilling process. Overpressure is one of the important drilling hazards seen globally, contributing to well control incidents and significant nonproductive times (NPT), sometimes even leading to early well abandonment. Standard practice is to prepare pre-drill Overburden-Pore pressure-Fracture gradient profiles from seismic velocity and offset well information (postdrill pore pressure/MDT/LOT etc.). Normally operators start drilling with high-mid-low case pore pressure profiles in hand, and mud weight is designed based on the best estimate of pore pressure. As drilling progresses, pore pressure is updated based on LWD logs, mud log data in real time and accordingly mud plans are revised. Eaton's equation is extensively used across industry, where normal compaction trends (NCT) are established to generate pore pressure. In many practical scenario across the globe, it has been commonly found that Eaton's output deviates from actual pore pressure. Re-establishing NCT can be helpful, but most importantly direct downhole calibration data are required to establish the interpretation. Drilling events are very useful in this purpose, e.g. connection gas, influx/kick, kill mud weight information provide critical information to finalize pore pressure magnitude.

This case study is from a high pressure vertical exploratory well from a prolific Indian offshore hydrocarbon field. The well was drilled to Cretaceous basaltic basement till 3600m (TD), in 33m water depth. Predrill study estimated a pressure ramp in early Eocene followed by an overpressured Eocene-early Paleocene shale with maximum pore pressure reaching 14.7ppg.

Real time pore pressure analysis followed the predrill model till mid Miocene Limestone (base at 2160m). Final well section was drilled with 8 ½" bit and 11.5ppg mud. At 2362-2364m, an increase in return flow was observed and well was killed with 12.5ppg mud. The Operator started carrying out fingerprinting prior to every connection beyond this point to check for any influx trend and early kick detection. High background gas and connection gas continued in 2372-2419m and mud weight increased to 12.7ppg. At 2561m, gas increased to 30% and the well started flowing, BOP was closed, initiated well killing by drillers' method using 14.2ppg mud weight. After two days of continuous endeavor (NPT), the well was killed with 15.5ppg mud, average flow reduced to 0.3bbl/min. Further drilling continued with 15.5ppg mud till 3250m. This section recorded flow rate of 18-24bbl/hour at several depth points (2672-3236m interval). From 3250m onwards, the Palaeocene shales showed clear indication of further increasing pore pressure trend on LWD resistivity log responses, high background and connection gases, influx (recorded 7.5-12bbl/hour at 3350-3578m interval), cavings and multiple tight spots encountered while reaming, and these led to the increase of drilling mud weight from 15.5-16.8ppg. Upon reaching TD at 3600m, fingerprinting carried out and flow check in trip tank recorded a 7.5bbl/hour influx with 10-13% background gas and 23% connection gas. The well was finally killed by drillers' method with 18 ppg mud prior to final POOH to surface.

Real time pore pressure interpretation has been presented in the figure below. The studied well is a perfect example where drilling event based interpretations helped operator to finalize pore pressure in real time. Influx events and kill mud weight were instrumental in establishing real time pore pressure profile against the high pressure Paleocene shale, while the predrill pore pressure gradient and Eaton's output (from LWD resistivity) quite deviated from the actual pore pressure.

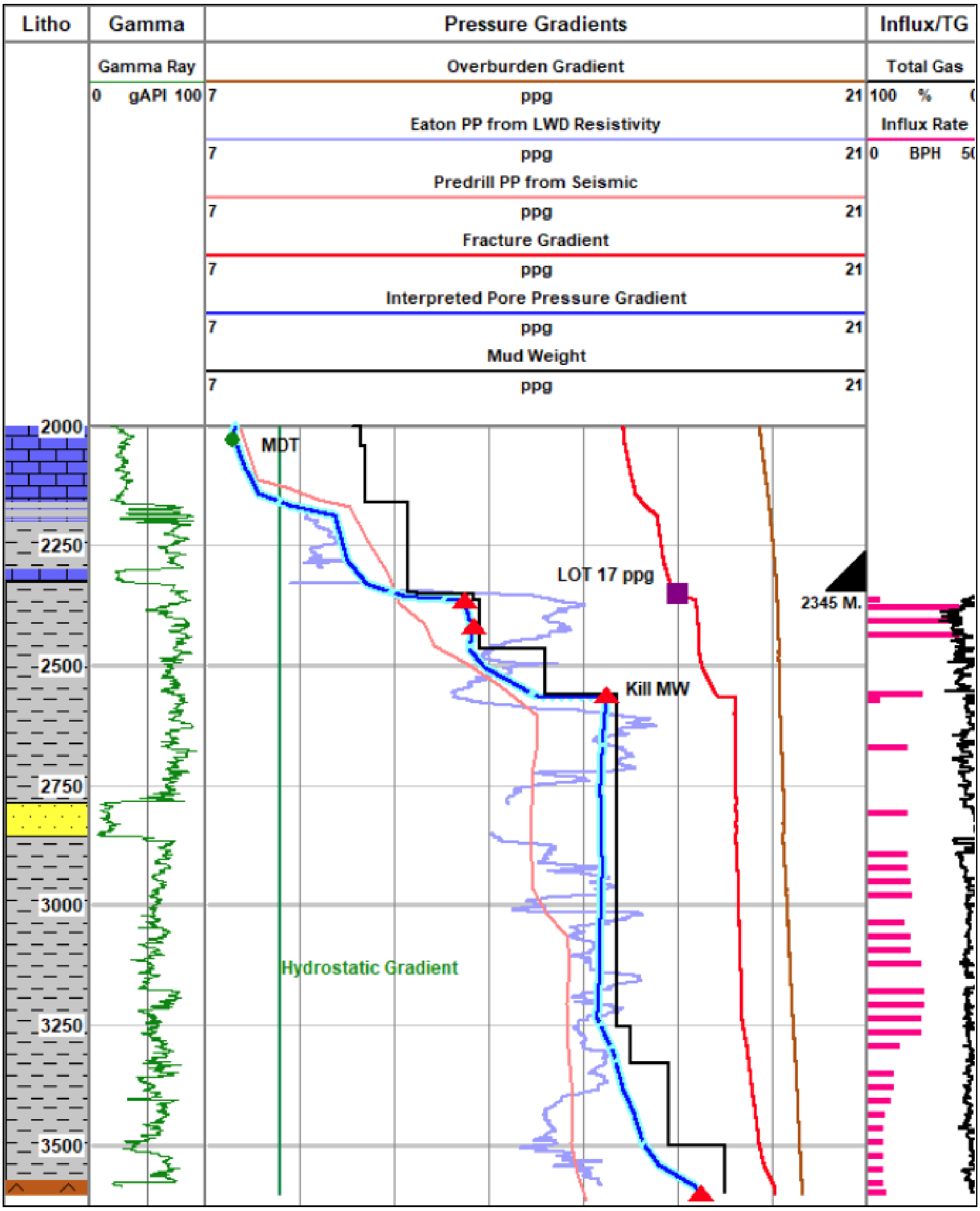

Fig. Interpreted OBG-PP-FG calibrated with drilling events in the studied offshore well, output taken from Pore Pressure module, GEO Suite of software

This case study shows the importance of carefully studying drilling events in a real-time environment, although LWD data remains the primary source for pore pressure calculation. Even log responses can be misleading in case of high silt and TOC content, radioactive non-shales, washouts etc. Connection gases, cavings, influxes are direct indicators of the formation pressure anomalies, which might be missed if calculation is solely dependent on electric logs.

NOTES:

Day One:
Session Two: Formation Pressure and Geomechanics

Challenges in pressure predictions and communications with operations/drilling

Richard Swarbrick
Geopressure Consultancy Ltd

"Fit for purpose" pore fluid pressure (PP) and fracture pressure (FP) predictions remain paramount to ensure execution of safe but cost-effective drilling programmes. Geology underpins these interpretations, i.e. knowing the rocks and fluids and their properties and applying realistic models to new well locations and/or to the pathways of fluid movement where depletion and/or fluid re-injection are involved. Historically, predictive relationships for pore fluid and fracture pressures originated in the Gulf of Mexico, a classic deltaic setting, but not especially applicable to many other areas. Geological context is the most useful starting point for developing useful predictions – lithology strongly influences pore pressure distributions whilst regional/local stress impacts on fracture strength. Estimating FP invariably incorporates knowledge of the PP. A new global FP algorithm incorporating an overpressure - fracture pressure coupling term will be assessed in terms of its applicability to several SE Asia and Australian basins. Improvement in predicting pore fluid pressures are emerging from advances in seismic data analysis, including full waveform inversion providing direct interval velocities, and the ability to measure pressure in microDarcy permeability rocks will improve calibration of PP prediction. Standardisation of borehole fracture strength testing (e.g. the Leak-Off test procedure) would benefit FP calibration and reduce uncertainty. Wider availability of global analogues supported by databases of observed/measured PP and FP would be of high benefit too.

Transferring the pre-prediction PPFG plots forward to Operations/Drilling poses some serious challenges, not least the need to communicate the uncertainties and their reasons effectively to a community historically more accustomed to a relatively precise set of values. Moving between pressure-depth plots (the required display for geoscientists to assess many of the relationships which govern pressure predictions) and equivalent mudweight-depth plots (necessary plots for well planning/drilling operations) raises communication challenges. There is a danger that the science which supports the early PPFG interpretations will be lost. This paper sets out the context for good practice in PPFG prediction and communication onwards to Operations/Drilling.

NOTES:

Geopressure uncertainties in salt systems – link between academia and industry

Gerardo Gaitan
Royal Holloway University of London and AAPG YP committee member.

Geomechanics and pore pressure prediction are the sciences that integrate geophysics, geology, petrophysics, rock and soil mechanics to quantify the responses of the Earth to any changes in state of stress, pore pressure and temperature. Geopressures are an important and relevant factor in any upstream operation team. From exploration to production, a comprehensive understanding of pore pressures and in-situ stresses are necessary for a safe and successful well. The main interest of geomechanics and pore pressure prediction comes primarily from the oil and gas industry but it is also relevant to the energy sector, i.e. fractured reservoirs, geoengineering and nuclear waste disposal.

The lack of understanding of stresses and geopressures could lead to different problems during drilling operations. These problems are well known to the oil and gas industry, e.g. elevated torques, complete well collapse, kicks, and ultimately, a blowout. Lost circulations, kicks and wellbore instability are problems entirely related to geopressures and are the main reason of Non Productive Time (NPT) during drilling operations. NPTs, in the oil and gas industry, could be up to 100 days per year or more. Taking in consideration that platform operations in ultra-deepwaters could cost up to $ 1M per day, it is easy to understand why an understanding of geomechanics and geopressures is relevant to any exploration oil and gas company.

An introduction to basic concepts of geomechanics and pore pressure prediction is important to both, academia and industry. This presentation aims to introduce and recapitulate concepts and methodologies that are of interest academically and to the energy sector. Moreover, a generalized case study of the Gulf of Mexico will be introduced to highlight the importance of assessing paleo-stress reorientations in the pre-drill stage supported by the frictional faulting theory, numerical, finite and analogue modeling.

NOTES:

Maximizing the Potentials of Petrophysical Rock Properties in Deep Formation Pressure Analyses

Kingsley Nwozor
Department of Geology, Chukwuemeka Odumegwu Ojukwu University, Anambra State, Nigeria.

Overpressure is known to be primarily caused by disequilibrium compaction, a situation that is due to the ineffective dewatering of deposited sediments even as the overburden load increases. However, as the depth of burial increases, thermally-driven processes (e.g. clay diagenesis, chemical compaction and hydrocarbon generation), could set in and begin to further increase the amounts of overpressure in the system. Unlike disequilibrium compaction, late overpressure is not easily quantified by standard pore pressure prediction techniques that rely on the relationships between vertical effective stress and rock properties. Therefore, accurate pore pressure prediction and the modeling of overpressure along a well path will require the discrimination of late overpressure regimes from disequilibrium compaction settings. The conventional practice for this identification is the use of crossplots of mudrock properties especially those of velocity versus vertical effective stress and velocity versus density. Interpreting the crossplots requires the recognition of virgin curve compliant data that could be attributed to normal pressure and overpressure caused by disequilibrium compaction; data that deviate from the established virgin curve would be considered to be suggestive of late overpressure. Whereas it is trite to make these two broad categorizations on a VES-velocity crossplot, recent developments in formation pressure analysis show that variegated patterns (e.g. vertical downward, horizontal and diagonal) on velocity-density crossplots that are widely ascribed to specific late overpressure mechanisms requires deeper insights for the interpreted mechanisms to be geologically realistic. By modelling the known VES-rock property relationships for unloading (fluid expansion mechanisms; i.e. gas generation), it is shown that unloading due to gas generation can assume other geometries on the velocity-density crossplot other than the more popular vertical downward drop. The reality is that the patterns observed on velocity-density crossplots are the results of a conspiracy of many factors that include the causal mechanism of overpressure, amount of overpressure and habitat of overpressure (i.e. whether the pressure regime is a transition zone or an equilibrated pressure cell). It is therefore suggested that mudstone velocity and density are at the moment grossly underutilized as formation pressure analytical tools.

NOTES:

Overpressure Transfer through Interconnected Igneous Intrusions: A New Mechanism for Overpressure Development in Sedimentary Basins

Nick Schofield[1], Simon Holford[2], Alex Edwards[3], Niall Mark[1], Stefano Pugliese[4]
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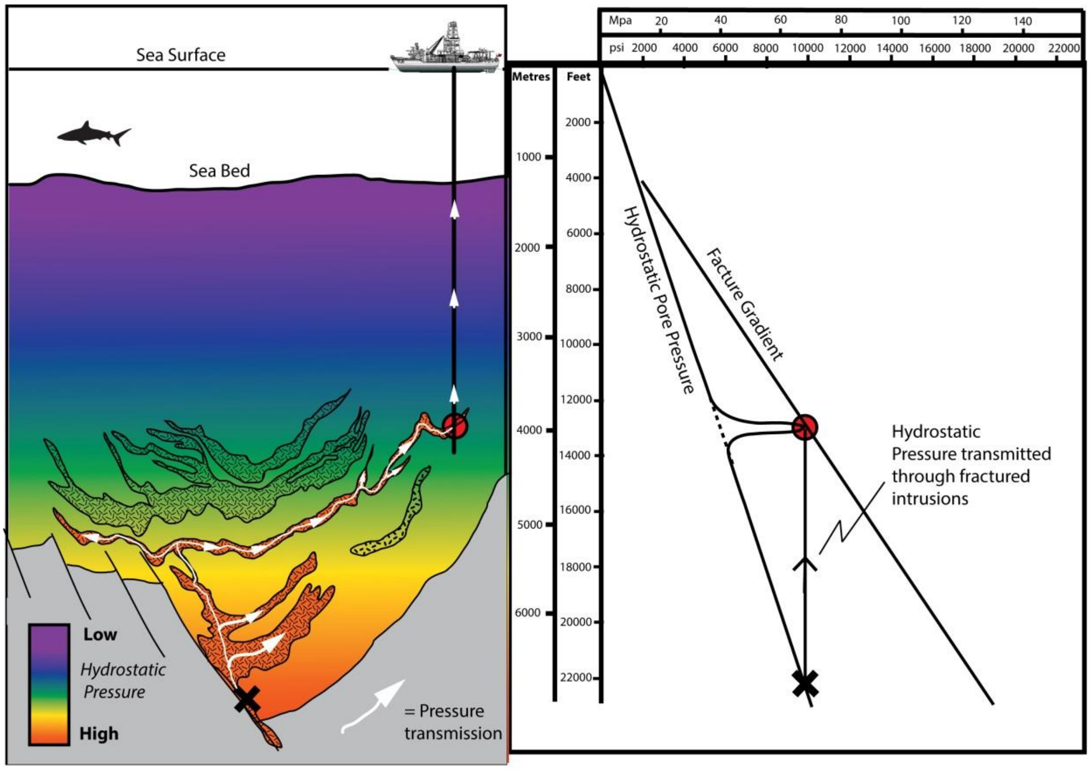
Background and Context

In 2016, the Loanan well (214/23-1) located in the Faroe-Shetland Basin was prematurely TD'd as a result of inadequate kick tolerance given the probability of encountering an overpressured igneous intrusion within the secondary target (see Mark et al. 2017). Within this contribution we will explore the evidence base that lead to that decision.

Abstract

Mafic sill complexes are common features of sedimentary basins at rifted continental margins. Such complexes often comprise networks of interconnected sills, dykes and inclined sheets that facilitated the transfer of magma over considerable vertical distances to shallow depths within sedimentary basins. One such basin is the Faroe-Shetland Basin on the NW European Atlantic Margin, where the extensive Faroe Shetland Sill Complex (FSSC) was emplaced during the Paleogene across an area >22,500 km^2. The FSSC was predominantly emplaced within Cretaceous shales, and is characterised by a pervasive network of interconnected, vertically stacked intrusions that extends from ~2 km beneath the present-day seabed, to depths >6 km.



The FSSC has been penetrated by 27 wells, with many wells experiencing loss of circulation events when drilling through intrusions. Combined with core data that provide evidence for fractures, these observations suggest that certain intrusions within the FSSC may host permeable, open fracture systems, even at present-day depths >5 km. Most notably, well 214/28-1 encountered 9 mafic intrusions at depths between ~3.8 and 5 km, including overpressured, thin (<8 m), fractured gas-charged intrusions at ~4.6 and 5 km, respectively. These overpressured intrusions form part of a series of interconnected sills and inclined sheet intrusions that can be mapped on seismic reflection data, and appear to connect to the deepest parts of the basin.

The overpressures could possibly reflect local gas generation related to thermal maturation of the surrounding Cretaceous shales during emplacement of the intrusions, though this would require the overpressures to have been sustained for >50 Myr. Our preferred interpretation for the origin of the overpressure is that the interconnected intrusions have acted as fractured conduits that link to pressure regimes from deeper in the basin. This hypothesis is consistent with the observations of open fractures within deeply buried intrusions in the FSSC (and in deep intrusions in other basins), and with evidence that fractured intrusions have provided migration pathways for petroleum fields located at the edge of the FSSC, such as the Tormore gas field. Our results suggest that transgressive, interconnected sill complexes may represent a previously unrecognized means of vertically transferring pressures (and indeed hydrocarbons) from deep to shallow levels in sedimentary basins. Given that the majority of intrusions in sedimentary basins are too thin to be resolved on seismic reflection data, our results highlight the difficulties associated in planning exploration drilling near interconnected intrusive complexes.

NOTES:

Integrated Risk Management Approach Improves Drilling Performance in Complex Geological Settings

Bordoloi S, Basu P, Chatterjee A, Embry J-M
Baker Hughes a GE Company

Objectives/Scope: Numerous sub-surface studies in different geological settings from the major sedimentary basins around the globe lead to development of a Geomechanics-centric workflow, which is part of an integrated risk management approach, focused on driving out Non Productive Time (NPT's) by reducing drilling and geological uncertainties. The primary outcome of this approach is safe drilling, reduced NPT, and assurance to attain planned total depth or targets. Consequently, it has a big impact in ensuring a safe, and efficacious drilling program.

Methods, Procedures, Process: The integrated approach is part of a broad planning and execution process, attempting to holistically find mitigating solutions to potential drilling and geological risks in each planed well section. Solution are found by drawing on the Geomechanics expertise; as well as technologies from drilling engineering, geosciences and drilling fluids. The foundational part of the integrated strategy is a pre-mitigation risk assessment (based on the geomechanical model) process that helps identify the probability and impact of a risk in terms of safety and NPT, and thereby helps to design most appropriate solutions for proactive risk management.

Results, Observations, Conclusions: This workflow has been applied in different parts of the world ranging from offshore drilling in Asia Pacific to North Sea in Europe targeting both shallow and deepwater reservoirs. The deployment has provided a structured project management approach and resulted in reduction of potential high-risk events to low- or no-risk events by using technologies and services necessary to mitigate risks to acceptable and cost effective levels.

Innovative Information: The integrated risk management strategy, through Geomechanics as a central theme, provides a cost-effective, yet a highly focused barrier management approach starting from pre-planning through to execution, thereby allowing safe, predictable operations from start to finish.

Case Study 1:
HPHT Well Offshore South East Asia
The well was designed to drill to a depth of 3500 m with an overpressured Miocene-Oligocene sediment column of 2500 m (water depth 90m, maximum prognosed pressure 10,000 psi and temperature ~190 deg. C). An integrated risk management approach was adopted through a robust predrill analysis with realtime monitoring of the well and updating the predrill model wherever required using the new information. Overall collaboration with different subsurface and operation teams helped in day-to-day updates like the Pore pressure & Fracture gradient (PPFG) risk overview based on risk matrix, realtime recommendations, and detailed geomechanical analysis during drilling of the well. Based on postdrill analysis, the actual pore pressure was within the uncertainty model which helped to make decisions on well design while drilling. The predrill model predicted a manageable, but a very narrow mud window for deeper cycles.

Case Study 2:
Horizontal Well Offshore South East Asia
From a geomechanics and wellbore stability point of view, highly deviated wells require higher mud weights to drill successfully to limit the wellbore breakouts. There was a need to prevent failure in weak and reactive silty shales that are inter-bedded with the competent reservoir sand. Equivalent circulating density (ECD) control, monitoring cuttings and good hole cleaning were keys to eliminate the wellbore stability problems during drilling this horizontal hole. The project involved initial drilling of pilot wellbores to evaluate the presence and lateral distribution of gas-charged sand bodies along with evaluating the reservoir petro-physical properties of the encountered sand reservoir. Confirming the Gas-Water-contact (GWC) in the pilot well-bores allowed design and placement of the planned horizontal wellbore. Prior to drilling, the Baker Hughes Reservoir Navigation experts conducted a comprehensive pre-well planning and modelling process with multiple offset-wells and digital-horizon data. This well delivery included monitoring the cuttings, cavings and drilling data, providing real-time borehole collapse pressure taking into account the amount of overbalance to minimise the formation damage, analysis of image logs to assess potential mud losses into identified high-angled features and wellbore trajectory optimisation in respect to weak

bedding planes of inter-bedded shales. Real-time LWD data was used to calculate the collapse pressure for mud weight optimisation during drilling.

NOTES:

A case study of the Mckee-13 blowout, Taranaki Basin, New Zealand

Sean O'Neill[1], Stuart Jones[1], Richard Swarbrick[1], Peter Kamp[2], Robert Crookbain[3]
[1]*Durham University*
[2]*University of Waikato*
[3]*Shell Taranaki*

The McKee Field is situated in the Tarata Thrust Zone on the eastern boundary of the Taranaki Basin, New Zealand, and consists of a series of en echelon thrust faults and associated anticlines, of which the McKee structure is one. The McKee Field is comprised of a number of adjoining fault blocks that produces oil, gas and condensate from a steep south-easterly dipping (up to 60°) sandstone reservoir sequence truncated against a deep thrust.

McKee-13 was spudded in January 1995, 11 years after production started, as the c.35th well to be drilled on the McKee Structure with the aim of improving drainage between two current producers. The well experienced a pressure kick on entering the Eocene Mangahewa Formation culminating in an underground blow out, which resulted in hydrocarbons breaching the surface and eventually a total loss of the well. The overpressure in the Mangahewa Formation was not predicted, so a light drilling mud of 9.8 ppg was used and a 1679m section was left uncased, resulting in a narrow drilling window and low kick tolerance.

An offset well along the structure, Toe Toe-2, experienced a pressure kick in the Mangahewa Formation at the same depth as McKee-13. The calculated formation pressure from this kick is anomalously high for the depth, requiring a mechanism to transfer this pressure into the shallower stratigraphy. A recent well drilled in 2010, Beluga-1, down dip of the McKee field encountered overpressures of 1500psi in the Mangahewa Formation. If we assume that the Mangahewa Formation is confined and in lateral continuity, then that pressure is transferring up dip via the process of lateral transfer.

A mudweight of 12.3 ppg would be required to contain the pressure, which would easily breach the fracture pressure below the 9 $^{5/8}$" casing set at 595 mTVDgl when transferred up-dip and into the borehole. This study highlights the need to ignore preconceptions, properly appraise all offset well data, and integrate regional geology into well planning.

NOTES:

Day Two:
Session Three: Risk and Safety of Operations

KEYNOTE: If learning is so useful, why don’t we do it? Psychological and organisational insights into the challenges of collective learning

Kristina Lauche
Professor of Organisational Development and Design
Nijmegen School of Management – Radboud University
The Netherlands

Collective learning; why it doesn’t happen as often as it should, what makes it difficult and how you could approach it to make it happen.

Imagine we would succeed in learning lessons well as a professional community – how would that look like? We would be able to avoid and prevent known problems because we understand why things sometimes work and sometimes don’t, resulting in accurate predictions and reliable relations among colleagues within and across disciplines. Even those who have not been directly involved in a given event or who are new to the business would understand and apply what those with direct experience came to understand.

The value of learning lessons well is obvious both on the individual and the organisational level. Yet somehow it does not happen as often, as smoothly, as thoroughly as one would hope. It is a bit like quitting smoking or drinking: the doctor might tell you that it is good for you, but it still takes effort and can be a painful process.

The talk draws on research about collective learning, reflective practitioners and appreciative inquiry to provide an understanding of the challenges and possible ways forward. As an illustration, a recent analysis of attempts to promote insights into Human Factors in the drilling community in the wake of Macondo will be presented. Despite the relevance of psychological and organisational knowledge for the preventions of accidents and reduction of non-productive time, the cross-disciplinary learning process turned out to be cumbersome and sticky. The talk will conclude with recommendations on how to learn lessons individually, collectively and as a profession.

NOTES:

Well S-33 Well Control Incident in Southern Oman: Causes and Outcome

Hilal Shabibi, Tromp Jan Pieter, Abdullah Riyami, Abdullah Hadhrami, Attia Mohamed Ziada, Yousef Maashari
Petroleum Development Oman

The Cluster consists of 12 different reservoirs all of which have their own different characteristics. The reservoirs are deep, highly pressured and contain sour up to 100,000 ppm of H2S, light hydrocarbons. Over 100 wells have been drilled in these fields. Carbonate reservoir stringers are usually developed in phases; primary depletion to reduce reservoir pressure until wells lift die out, then miscible gas injection to achieve desired oil recovery factor of up to 50%. Sour gas is injected at high pressure above minimum miscibility pressure.

The Pre-Cambrian reservoirs are completely encased in salt. There are carbonate floaters inside the salt section that are normally tight, highly pressurized and small in size. Due to the limited lateral and vertical sizes some Floaters are not detectable in the seismic data and hence their presence can't be confidently predicted. Most of the wells are deep at depth between 3 - 5 km and with high pressure between 40,000 and 100,000 kPa. The hydrocarbon column height for these reservoirs ranges between 70- 150 meters. These fields are characterized by the presence of two Ara Carbonate stringers: A2C and A3C separated by a salt Package.

The main challenge when drilling for these reservoirs (carbonate stringers) is the ability to safely drilling through the salt and the highly overpressure floaters in combination with identification of good reservoir properties and successfully completion of the wells. In this study, details of the well control incident from S-33 well will be presented.

Typical well and completion design includes 18 -5/8” and 13-3/8” surface casings to isolate shallow water aquifers, prevent contamination, and corrosion issues. 9-5/8” production casing is run and cemented to isolate shallow pre-salt weak formation before drilling into salt stringers, and as drilling conduit for high pressure operation. Section 7” liner is usually run and cemented to isolate high pressure floaters before drilling into target reservoirs that are usually cased off by 4-1/2” liner. To achieve pseudo-monobore, 4-1/2” tubing is run as completion string. Salt saturated mud systems are usually used to drill through salt sections. Mud weights ranges from 12 to 22 kPa/m to maintain well control during drilling operations through the highly pressured floaters and reservoirs.

The cluster is classified as one of the most challenging fields in southern part of Oman in terms of drilling. The drilling challenges occur mainly in the 8.3/8’’ section while penetration a thick salt formation that contains high pressure carbonates bodies. In the 5 7/8’’ hole; i.e. in reservoir section, the typical issues encountered differential sticking and losses due to the high uncertainty of pore pressure prognosis.

This paper will also highlight the causes of the well control incident that occurred during drilling of the 8 3/8” section on well S-33, experienced high intensity kick due to drilling into an unexpected permeable floater (A3EF1). After shut in the well, the SICP exceeded the MAASP which resulted in formation breakdown below the liner shoe and led to underground cross flow from the floater to the depleted A3C reservoir.The well was delivered as A3C well and regret of A2C the primary target, and a replacement dedicated A2C well was later delivered without impacting the planned development or well configuration.

NOTES:

A complete gas-risking workflow for top-hole drilling studies

Francis Buckley and Lewis Cottee
Lloyd's Register Survey and GeoEngineering

The most effective method of mitigating the risk of drilling into shallow gas reservoirs is by moving drilling locations to avoid seismic events interpreted to represent a probability of gas. It may be the case however, that some well locations are constrained by wellpath or reservoir target considerations, or that there are no areas clear of interpreted shallow gas phenomena to which a drilling location can be moved. It has been shown (Buckley & Cottee 2017) that top-hole drilling assessments of gas probability may significantly be enhanced by the application of more rigorous geophysical interpretation methodologies based on the principles of AVO and petrophysical well-log analysis, but gas probability assessments are only the initial step in devising risk mitigation strategies for top-hole drilling. A case-study describing a more complete risk assessment process is presented, in which the physical characteristics of a shallow gas reservoir are estimated, likely gas volumes and pressure regimes are calculated, and a prediction is made of the effects of drilling into the reservoir.

A seismic anomaly (see Figure 1a, 1b) lying at a depth of approximately 1000m TVD beneath a proposed well location is interpreted, on the basis of industry-standard criteria, to represent a 'Moderate Probability' of shallow gas; i.e. that the anomalous response may be caused by gas, but that alternative explanations are just as likely. An AVO intercept/gradient crossplot (Figure 1c) confirmed that the amplitude anomaly coincides with a Class III/IV AVO anomaly and therefore more likely to represent gas (i.e. a 'High Probability' of gas). The anomalous event is a high amplitude reverse polarity reflection covering an area of approximately 8 km^2. It is cut by several deep-seated normal faults and compartmentalised into three sub-units, although pressure and fluid connections via the faults are likely. An underlying normal polarity anomalous amplitude reflection marks the base of the supposed reservoir, the thickness being close to tuning thickness (10m – 12m) across much of its extent, although thickening locally to values of up to 53m.

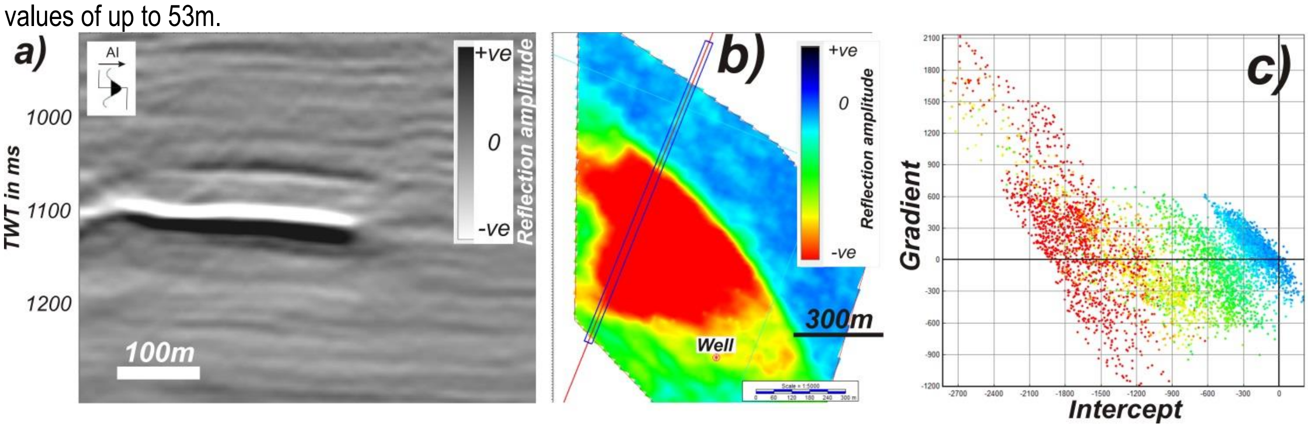


Figure 1 Seismic anomaly characteristics; a) 3D seismic section; b) Plan view of amplitude variation; c) AVO intercept/gradient crossplot – colour scale same as b).

Wireline log data (see Figure 2) from an offset well that was drilled through the margins of the anomalous reflection, indicate the presence of a thin sand unit (GR curve) and a possible hydrocarbon response (Deep Resistivity).

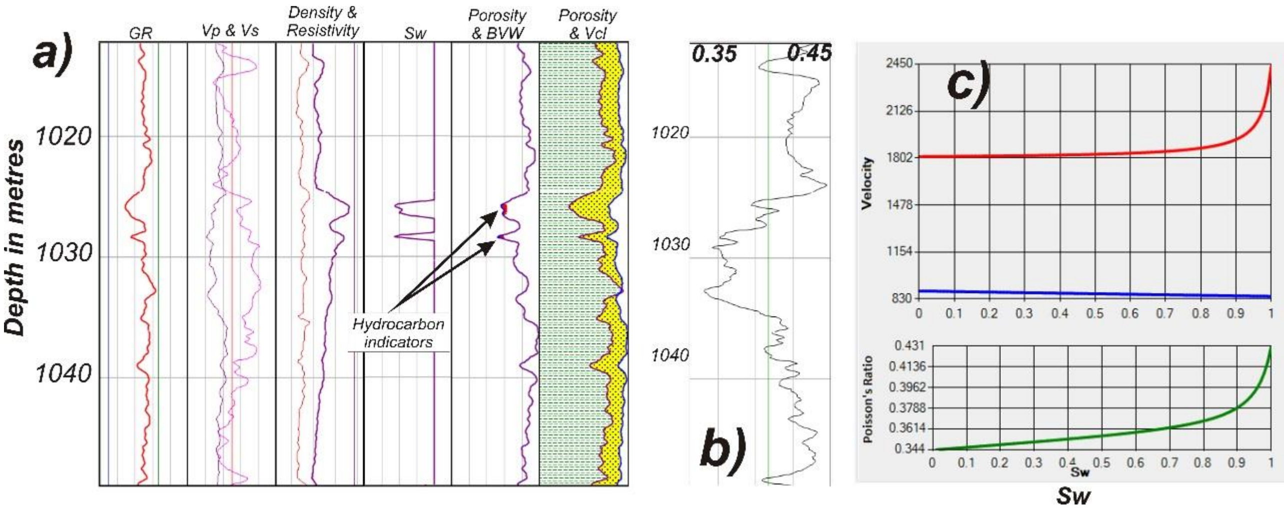


Figure 2 Log analysis results; a) Log analysis panels (GR = Gamma Ray, Vp = Compressional Wave Velocity, Vs = Shear Wave Velocity, Sw = Water Saturation, BVW = Bulk Volume of Water, Vcl = Clay Volume; b) Poisson's Ratio curve; c) Gassman's fluid calculation graph curves.

Well-log analysis indicates that lithology of the anomalous reflection interval may be up to 70% sand content with porosity approaching 22% and with a marked decrease in water saturation. There is a decrease in Vp of up to 325 m/s at and just below the sand unit, roughly corresponding with raised resistivity values. A Poisson's Ratio value of 0.37 was calculated for the gas-bearing unit, compared with a background value of 0.40 – 0.42. Gassmans fluid calculations (Gassman 1951) based on these values reveal gas concentration at the well to be in the order of 20%.
Inversion of seismic data to P-Wave and S-Wave impedance volumes indicates a gas-bearing interval of approximately 12m at the proposed well with gas concentration values comparable to those at the offset well, although seismic inversion data suggest that greater gas concentration values could be present in other parts of the reservoir. Volumetric calculations result in a hydrocarbon pore volume (HCPV) of 0.00623 km^3 at reservoir conditions, with the gas column at the proposed well measured at approximately 42m and gas buoyancy resulting in a predicted pore-pressure 1518psi (8.68ppg) at the top of the gas column in comparison with 1455psi (8.32ppg) expected from a background hydrostatic pore pressure at this depth. Addition of the formation factor to the volumetric calculations results in an equivalent volume of gas at surface conditions of approximately 0.635km^3.

A proposed well is predicted to drill through an anomalous event likely to represent shallow gas reservoired within a sand unit. Volumetric calculations have shown a large amount of gas-in-place and pore-pressure gradient and gas buoyancy calculations have shown that, without prior warning, these could overcome normal drilling mud-weights. A further consideration is the extent to which the deep-seated faults cutting the sequence either compartmentalise the reservoir or facilitate gas migration and connectivity to much higher pressures.

NOTES:

Fast Paced Learning in a High Activity Onshore Tight Gas Field

Mike McTeague, *Ibrahim Al Rahbi*
BP Exploration (Epsilon) Ltd.

BP acquired a large block in Northern Oman in 2007 to appraise the tight gas resource of the Cambro Ordovician sandstone reservoirs. Block 61 covers ~3000km^2 and contains reservoirs of the deep Haima gas play. The Barik is the primary reservoir in Khazzan. The deeper terrestrial sandstones of the Miqrat and Amin Formations are secondary targets within the block. Reservoir quality in Khazzan Makarem sandstones is poorer than in surrounding fields due to advanced quartz diagenesis which makes the development more challenging than nearby fields. BP brought global experience in drilling and hydraulic stimulation in tight gas reservoirs to make commercial gas rates that supported a field development. The field is estimated to contain a very large resource of natural gas.

The appraisal drilling campaign began in 2009 and consisted of 15 wells (13 vertical and 2 horizontal). The project was sanctioned, and early stages of development drilling began in 2013 with a single rig. The team went from operating one drilling rig to supporting ten rigs in a year's time. There was a very steep learning curve for the team as activity ramped up from drilling 3 wells a year to 30 wells in a year. The relatively new team was faced with the task of coming up with an efficient workflow to identify and mitigate drilling risks. The daily drilling data from the historic BP wells were transferred into excel where key words that indicated drilling problems could be rapidly searched, identified, and cataloged. A robust database of non-productive time and invisible lost time drilling events was built from the early appraisal wells. This database includes everything from minor tight hole to high non-productive time stuck pipe events. Each event includes a description, category, depth, date, formation, and total lost time. These data were then loaded into Petrel for 3d visualization to assist with risk identification while planning new wells. These data can be easily viewed and filtered in Petrel. The database also lives independently in excel to allow it to be easily shared with the drilling department and wellsite geologists. Once the historical drilling events were captured, the workflow shifted to documenting non-productive and invisible lost time events in real-time. Now these events are documented as they happen which allows for improved clarity and understanding of the problems. Essentially the end of well review is written while the rig is still drilling. The fast and efficient workflow maximizes the team's ability to learn from recent wells. This is especially important due to the large number of rigs and fast paced environment. As one well is being drilled, the well next door is being planned.

In addition to the offset well database, the need for close communication between the teams was critical for the success of the project. The success of the well planning and operations team was founded on a close collaboration with the drilling team and wellsite geologists. Colocation of the operations geologists enabled open communication and allowed for ideas to be discussed and share freely. The drilling department works on the same floor and is just a few steps away which significantly improves communication between the different teams. The impact of the focused team with a deep understanding of subsurface risks and collaboration with the wells team is substantial. In just over two years after the start of factory drilling the average time of vertical wells has dropped from 110 to 66 days and non-productive time has decreased from 23% to 15%.

NOTES:

SNS Well Abandonments – 4 Years On.

Christopher Grieve, James Gifford
ConocoPhillips (UK) Ltd.

ConocoPhillips embarked in 2014 on a P&A campaign of their Southern North Sea assets. The Well Operations team were faced with plugging and abandoning 140 wells. Using a risk-based and fit-forpurpose design, the team have now abandoned 70 wells using a combination of rig and rigless solutions. To begin with, it was taking over 30 days to abandon a well. By leveraging experience, lessons learned and adapting the P&A process, the average time it now takes to abandon a well has been reduced to less than 13 days in 2018. After the initial abandonments it became apparent that rather than working in isolation, with little geological input, to be effective a fully integrated team approach was required. Over time this has expanded to include a full-time abandonment Operations Geologist, 24-hour petrophysical cover for cement bond log interpretation, as well as geophysical and reservoir engineering input. The geological operations workflow for abandonments is now akin to that for drilling a new well, requiring as it does; a thorough offset well study, PPFG plots and production of 1-page geological summaries. This stands in contrast, to the Well Operations “destruct” rather than “construct” mindset. The propitious combination of a change in the Oil & Gas UK abandonment guidelines in July 2015 married with strong geological input has reduced the number of barriers required in ConocoPhillips’ well abandonments and led to significant savings. This presentation will not only show how this was achieved, but look to potential time saving innovations for the next 70 SNS wells, and how the “one team” concept has been extended to Central North Sea P&A campaigns.

NOTES:

Wellsite Chemostratigraphy: An *elemental* approach to wellsite operations

Paul O'Neill, John Martin, Rob Hall, Tim Morgan, Alex Findlay, Tim Pearce,
Chemostrat Ltd

'Where are we?' is a common question posed to the Ops Geologist during a drilling operation, particularly when going through the reservoir section! Conventional techniques and local knowledge can be used to shed light on the answer to this question, but there is an alternative – wellsite chemostratigraphy.

Chemostratigraphy is the characterisation and correlation of elemental data determined by XRF analysis. The technique has been previously used to identify key stratigraphic markers, unconformities, relative fault displacements, determination of stratigraphy for TD, geosteering, and placement of coring and casing points. Seemingly homogeneous rock formations can exhibit distinct geochemical trends that can be correlated to offset wells, offering an alternative to more traditional techniques such as biostratigraphy. Chemostratigraphy can also used in HPHT wells where LWD tools cannot be deployed.

In our talk we show examples of where our technique has been successfully used on Mesozoic formations in the North Sea.

NOTES:

Day Two: Session Four: The Value of Managing and Interpreting Data

Geosteering with a bigger torch: infill drilling results using Extra Deep Azimuthal Resistivity (EDAR) from Captain 13/22a-C63 / C63Z

Jenny Windress[1], David J. Moy[1], Phil Brock[2], David Holbrough[2]
[1]*Chevron Upstream Europe, Chevron North Sea Ltd*
[2]*Baker Hughes a GE company*

Producing for over 20 years, the Captain Field in the inner Moray Firth is a heavy oil field development of three reservoir intervals; the deep marine Early Cretaceous-aged Upper and Lower Captain Sands ('UCS' & 'LCS') and the shallow marine Jurassic Ross Reservoir, typified by relatively high net:gross, porosity and permeability, successfully developed by horizontal wells from a Wellhead Protector Platform (WPP) and two subsea centres. Over 300 MMbbls of oil have been produced via waterflood of the reservoirs, but to enable further recovery of unswept and bypassed oil, new technologies that can support optimisation of the development cost for drilling infill wells are needed to fully maximise the economic potential of the field.

Despite the downturn in price of crude oil, between 2016-17, the 10th platform development campaign further developed the UCS reservoir through four new infill wells, collecting surveillance data (injection logging) in 3 wells. The final production well of the campaign (C63) was in an area of the field with significant reservoir uncertainty towards the field edge. Using Logging While Drilling (LWD) azimuthal resistivity tools (BHGE AziTrak™ and VisiTrak™ technology), the well was successfully geosteered close to the reservoir roof, maximising the available recoverable oil.

However towards the toe of the well, around the uncertain reservoir edge, the well exited sharply to shale. The team presented the case to continue drilling,. By applying the Extra Deep Azimuthal Resistivity (EDAR) LWD technology, the reservoir sand was mapped below the well path, allowing the well to be geosteered to confirm the presence and thickness of the oil bearing sand. This exploratory section was drilled despite having exceeded the threshold for shale length in the completion.

The VisiTrak™ data was evaluated alongside other acquired LWD data to assess the value of a sidetrack. Potential length of shale between the main sand body and the toe and the impact of shale smearing while running completions through this interval were focus items. Resistivity inversion results from C63 were used to estimate the length of shale and influence the geometry of the proposed sidetrack, ensuring the well was planned to have no inclination changes (i.e. remain at 90º) whist drilling the shale interval.

The well was subsequently side-tracked to enable the development of the toe sands, with the acquired LWD data enabling the team to aggressively geosteer in a relatively thin reservoir and steeply dipping interval (see Figure 1). The shale length between the two sands was proven to be in the range estimated from the C63 data therefore minimising the chances of screen damage through this section.

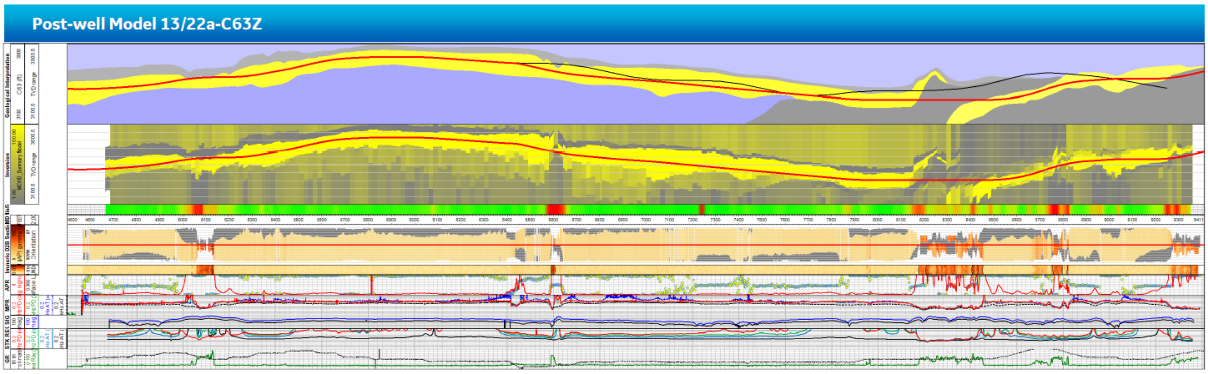


Figure1: Post well model provided by BHGE showing the MCWD inversion results for 13/22a-C63Z production hole (red) and the pilot hole (black in the top track)

Furthermore, the Extra Deep Azimuthal Resistivity provided a number of insights into both the geology and repeatability of the data collected. Data acquired during drilling of the sidetrack informed the team of the reservoir structure (interpreted as deepwater channel elements, see Figure 2) which in turn benefitted the geosteering strategy in this area, maximising well connectivity with the reservoir.

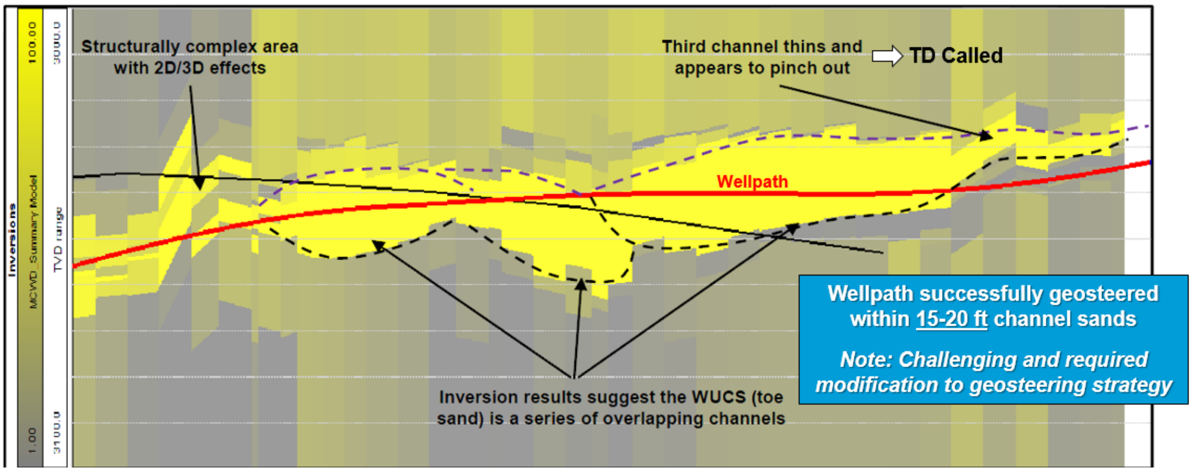


Figure 2: Post well model provided by BHGE showing the MCWD inversion results for 13/22a-C63Z production hole toe sand with an interpretation of potential channel elements

The inversion result in C63Z, compared with the result over the same interval in C63, highlighted a 4ft TVD discrepancy in the TVD of the upper boundary. Due to proximity of the two wells (20ft lateral separation) this was believed to be too large an error to be explained solely by geological dip. It was interpreted to be a result of survey error due to the distance between surveys during open-hole sidetracking. Application of continuous inclination data to the C63Z directional survey over the sidetrack junction eliminated the depth discrepancy and proved repeatability, providing the project team further confidence in interpretations from the VisiTrak™ inversion results.

Through technology and geology, the result has increased the estimated ultimate recoverable (EUR) of the well. Data acquired from this development will also enhance the planning and execution of future Chemical Enhanced Oil Recovery (EOR) wells in this area of the field.

NOTES:

Saturation Computation from Magnetic Resonance Logging-While-Drilling Data Recorded at a High Rate of Penetration

Stanley Oifoghe, Victor Okowi
Baker Gughes, a GE Company

The direct computation of hydrocarbon saturation is one of the applications of magnetic resonance (MR) logging-while-drilling (LWD). MR logging tools with a low magnetic field gradient have the advantage of a small diffusion effect on the Transverse Relaxation Time (T2), even for light hydrocarbons. Therefore, there is a high probability that the movable-hydrocarbon peak is completely separated from the irreducible-water peak. In such a situation, a simple cut-off approach can easily compute the hydrocarbon saturation. One potential limitation of this approach is related to the MR LWD data acquisition at a high rate of penetration (ROP).

In the past, one major challenge of MR LWD data acquisition was its limitation on ROP. Typically, MR LWD data is acquired at an ROP of less than 20 m/hr. A faster ROP can lead to MR ROP effects.

The first effect is known as the ROP-flow effect, which manifests itself as a faster decay of the MR echo train. The faster decay shifts the bulk movable porosity peak to shorter T2 values, and a fraction of the bulk movable porosity may shift below the bound water T2 cutoff. The second effect is the ROP-polarization effect, which mainly affects the polarization of the bulk movable porosity. The ROP-polarization effect increases the bulk movable porosity. If the acquired MR data is not corrected, the ROP-flow effect and the ROP-polarization effect can affect the computed hydrocarbon saturation and other volumetrics.

Fortunately, a newly introduced correction technique enables the compensation of both effects on MR LWD data caused by high ROP.

Most of the time, the ROP polarization effect is small and sometimes not noticeable. Previous publications have shown that the ROP correction technique can handle the typically low magnitude of the effect. In the case study presented in this paper, the light oil has a very long Longitudinal Relaxation Time (T1), which leads to a significant porosity overcall, in combination with the high ROP of the MR tool.

This paper shows that the MR ROP correction can properly handle significant ROP effects. The corrected MR data can be used to easily compute hydrocarbon saturation, which perfectly matches with saturation computed from resistivity data.

NOTES:

How advanced gas analysis provided the last piece of the puzzle to optimise production in one of Europe’s classic gas fields

Mariël Reitsma and Jonathan Watts,
HRH Geology

Advanced mud gas analysis at the well site can significantly improve the understanding of well characteristics resulting in substantial time and cost savings. It complements LWD data by directly looking at the hydrocarbons that are coming from the well rather than inferring fluid properties from petrophysical measurements. Advanced gas data gives a real time indication of, for example, the presence of producible hydrocarbons, proximity to pay, depths of original and moved fluid contacts and compartmentalization within the reservoir. HRH Geology’s standalone mass spectrometry system can detect straight chain and cyclic hydrocarbons up to C14, aromatic hydrocarbons like benzene, toluene and xylene as well as Helium, CO_2 and bit burn generated alkenes. After TD, wireline runs can be optimised by focussing on depths highlighted by advanced gas data.

The case study that we present is from a major European gas field. It has been in production for over 25 years but still questions about optimising field productivity remain. Specifically localised heavy cementation of the reservoir effecting porosity and permeability is not well understood. The development well discussed here had a target reservoir that extended across two fault blocks. The objective was to determine the nature of the fault and its effects on production of the reservoir.

Real-time gas analysis of hydrocarbon ratios and the presence of helium highlighted gas-water contacts at different depths on either side of the fault, indicating that the reservoir is divided into two compartments. Fluid fingerprinting demonstrated that slightly different fluids are present in each compartment with the wet gas in the deeper compartment having the lowest density. Moreover, pump off gas peaks were detected in this compartment indicating that it is overpressured. The conclusion reached was that the two compartments are neither in fluid nor in pressure communication and thus need to be produced separately.

Spectra has been used by operators throughout Europe and the Middle East to help characterise the overburden and reservoir in both previously exploited and new and complex geological plays.

NOTES:

Keeping Your Distance: Training Geologists Remotely

Gary Nichols,
RPS Energy, UK.

Maintaining and developing knowledge and skills is a challenge for all professionals, but geologist working on operations in remote locations face particular obstacles. Courses delivered in classroom venues or field locations are the ideal, but require a commitment to a time and a place in order to attend. The reality for many geoscientists is that work patterns preclude this commitment and a more flexible approach to skills development is required.

On-line or ‘e-learning’ allows training to be accessed in a way that may be more suited to the peripatetic geologist, but risks being an uninspiring and ineffective approach if not used imaginatively. However, with the appropriate use of technology and sounds pedagogic approaches it can be a viable and effective alternative to classroom training.

Key features that can make remote skills development work well include

(a) Learning that emphasises active engagement through exercises for which feedback is provided and self-assessment of progress available.
(b) Use of new technological approaches such as 3D ‘virtual’ outcrop images as illustrative alternatives to ‘real’ field visits, with associated observational activities.
(c) Interaction with tutors and peers during the course of the learning to create a virtual community of learners with remote access to expert supervision.

A vision for maintaining professional levels of skills and knowledge in the future would be a flexible, blended approach. Training elements would be available in different modes, delivered in the classroom and field where possible, but with the same content with the same learning objectives also available for study remotely. Geoscientists with work commitments that require them to be at different places at different times would have equivalent opportunities for professional development to those with fixed workplaces.
The presentation will include cases studies of how virtual outcrops can be used to develop and understanding of subsurface reservoir properties and heterogeneities as part of a remote training course.

NOTES:

Day Two:
Panel Discussion: Past, Present & Future

The Changing Face of Wellsite Geology – Abstract

Marcus Bawdon

I've been very fortunate, that I have been a Wellsite Geologist for many years, but have also been over the other side of the fence…poacher turned gamekeeper as it were as an ops geologist myself for a number of years, so I know very well how crucial the link between the two is.

Parts of the job of a Wellsite have changed hugely, but most have essentially remained unchanged.

Communication is still and will always be the most important part of the role. But the methods of communication have changed, but this only mirrors society as a whole anyway. Technology has revolutionised the link between offshore and onshore. But when you call from offshore late at night…you know…those 3am calls….having a succinct message from the wellsite is what's most needed….

As technology revolutionises the link between offshore and onshore, my worry would be that it reduces the importance of the wellsite geologist, but I think a good Ops Geologist – Wellsite relationship can empower the wellsite and strengthen the link for the good of the job.

Trends and Advances in Wellsite Geology

Peter Momme, Johannes Rossing, **Jon Watts,**
HRH Geology

Introduction

New trends in wellsite geology (WSG) will be presented and discussed from three angles: 1) A brief presentation of some of the new available technologies e.g. new LWD sensors, advanced gas analysis, correlation panels, offshore pore pressure analysis and how these technologies could change the industry in the coming years; 2) New trends observed in the field with focus on observed changes for the WSG's data management, daily duties and operational challenges; 3) Discussion and reflections from Ops Geos present and their view on the future role of WSGs.

New soft- and hardware possibilities

Logging software can present offset well data side-by-side with real-time data and thus supplement paper logs by using a correlation panel on a computer screen. This correlation feature is a very helpful operational tool since WSGs can reflect on pick criteria, as these may change over the time period in which the offset wells were drilled, and suggest more well-founded formation top picks to the onshore Geo team.

Other new software possibilities present the option for the WSG to do real-time pore pressure interpretation, understand and follow pore pressure variations while drilling ahead. Additional specialist interpretation can, of course, still be done in town, but the road is paved for the WSG to play a larger role in *numerically* evaluating the pore pressure real-time. There would be an obvious *health and safety* advantage with a WSG that can contribute with real-time data based operational input with respect to under- vs overbalance situations developing while drilling.

New advanced gas measurements based on portable mass spectrometry opens for a wide array of possibilities e.g. recognizing bit burning, steering in the reservoir based on gas components ("gas steering"), source characterization as well as recognizing reservoir compartmentalization while drilling. Equipment responsible engineers will be present offshore but data can go via the WSG during data streaming to the office and can play a large role for operational decisions e.g. steering the well.

Several new LWD tool technologies will be introduced in the near future e.g. 4D hole calipers rendering a 3D illustration of the wellbore for precise calculation of cement volumes, locating cutting beds in extended reach wells in addition to recognizing size and shape of enlarged zones in the well while drilling *and* POOH so wellbore size and shape can be compared over time (4D).

Acoustic fracture Imagers are also emerging to help better understand the nature of fault and fracture zones and losses while drilling e.g. faulted, severely uplifted and low pressured reservoirs of the Barents Sea. Both examples represent new LWD tools that are based on modern electronic components with gigabytes of downhole memory and designs with much higher sampling rates that will deliver high-density data sets. These will likely challenge operators' existing database layouts and RT data transfer rates from rig to office as well as inspire a movement towards advanced data base synchronization of large data sets over a sometimes patchy internet connection e.g. cloud computing solutions.

The same argument goes for existing LWD technology where service providers generally focus on increasing real-time data transmission rates to accommodate for faster drilling and supplying higher resolution data for better and more detailed geological analysis by using compressed data transmission with traditional mud column-based telemetry systems while drilling.

Trends in WSG

The role of the WSG is changing in part due to the technical advances mentioned above, data sets will have higher density and new types of data will be handled, analyzed, interpreted, included in reports and communicated to onshore colleagues for operational decisions to be made.

The wish for offshore personnel reduction is as relevant as always; we have seen Shaker Hands as well as WSGs ('Geologgers') collecting cuttings samples in order to cut down on offshore personnel. This has mainly been on production installations where no geological surprises are expected. If the implementation of new data heavy generating technologies for improving production from mature fields is combined with merging of offshore job roles there will be a need for clear definition and balancing of the WSG role.

Existing technological, planning and organizational options are not always used to optimize communication and solidity of the geological part of the operation from a WSG perspective.

There are several technologies that allow us to be within constant reach nowadays, but on some drilling operations the only communication options are a landline telephone and a PC with a network cable on the WSG's desk. Final casing- or coring pick often need confirmation from onshore Geologists so they follow the operation real-time while the WSG keeps an overview of samples (Logging Unit) and real-time formation evaluation data (WSG desk), but sometimes wireless communication options are lacking offshore, a risk that some operators have to- or are willing to accept.

WSGs are not always used in the planning phase but they easily could, and deliver know-how from previous operations. In addition, many WSGs have a solid background from a service company so they can often help tailor and optimize the geological sampling program and procedures to reach the operators needs in an efficient manner.

Drilling- and Geological programs are often followed by detailed Section Guidelines (DOP or DOG etc.) issued by drilling engineers and sometimes these are 'inherited' from previous operations where geological priorities might have been significantly different. We have experienced such guideline texts that have not been reviewed by the onshore geo team and the WSGs have observed and reacted to significant differences relative to the data program in the drilling program. This is just to highlight one experienced weakness in the often two-stringed organization, Subsurface/Geology and Drilling/Wells.

All in all we see general movement for WSGs to play a larger role in the planning phase, make broader founded integrated interpretations of the drilling operation when combining some of the above opportunities e.g. combining knowledge of a compartmentalized stratigraphy, based on advanced gas analysis, followed up by an increased focus on potential pore pressure variations.

Conclusions and challenges

We conclude that new advances in technology can potentially increase the WSG's role with respect to input for operational decisions in the future in areas such as pore pressure, well placement (gas steering, compartmentalization) as well as more broadly based integrated interpretations of the drilling operation compared to today. There will also be situations where a clear prioritized list of WSG duties must be specified especially if the WSG have expanded duties such as collecting cuttings samples. All systems related to data handling, transfer and storage, will most likely develop intensely as data from new sources becomes available and data density of traditional sources increases.

Communication between off- and onshore geologists will become more important with a future WSG more up-to-date with correlation to offset wells, pore pressure variations, changing gas response from the well, reservoir compartmentalization, wash outs and fractures just to mention subjects touched here.

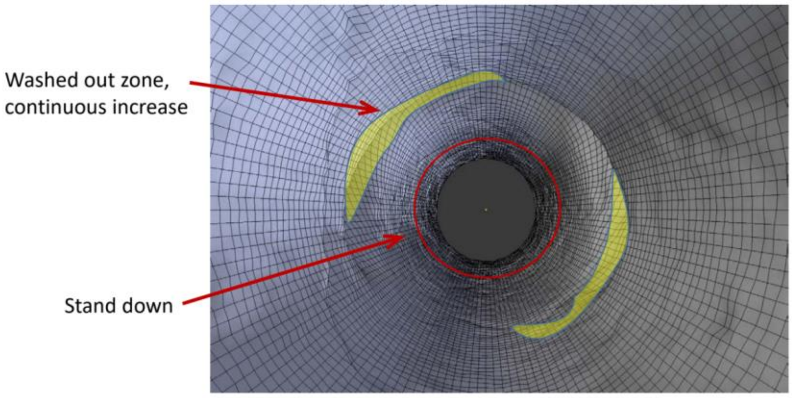
Themes for debate

We have covered a limited amount of observations as well as coming technologies and opportunities. Observation and perception may differ between us, but the above represents what we believe will have a role to play in the years to come.

Where do you see the WSG role moving to?
Where would you like it to go?

Figure proposals.

Figure 1. Illustration of enlarged hole measured by 4D Large Hole caliper LWD tool, top view. (Figure from Well ID)



Posters

In-Focus: Building Workforce Competency

Linda Steedman,
eCom

Why it helps organisations to thrive?
More emphasis is being placed on business outcomes and all departments are being asked to measure the effectiveness of their interventions. This has always been a very tricky area for training departments, as many of the interventions are subjective and can take years to demonstrate any benefit if ever. So to create metrics from a standing start can be difficult. This is where the introduction of competency tracking has taken centre stage amongst many large organisations.
Lack of workforce competence is a huge cost to an organisation, both to budget and reputation. Lack of focus on developing competence can also be a major contributing factor to poor employee motivation, satisfaction and retention.
The Towards Maturity 2016-17 Unlocking Potential report indicates that the majority (90%) of learning professionals want to play an active role in supporting business innovation.
Although recording that time to competency is down by 15% from last year, with only 22% of their learning provision via any sort of blended learning solution. Demonstrating the difficulties learning professionals are having with no adequate systems to quickly and accurately measure competence. This is all whilst 7 in 10 employees engage with online learning because they are motivated by being able to do their jobs *better* and *faster*. It seems the time is right for competence based assessment to be introduced into the workplace.
The earlier paper, with our take on building workforce competency, can be found here: https://towardsmaturity.org/2015/04/08/in-focus-building-workforce-competence/

About eCom
eCom develops innovative digital learning solutions that help organisations to develop the capable workforce they need to accomplish their goals. eNetEnterprise™, our flexible workforce development system is ideally suited to managing risk and safety operations and two of the modules, Comply and Onboard are key.

Comply enables organisations to manage compliance against legal standards and track staff competence against company goals and objectives.

Onboard, helps automate the processes that support training, enforcement of policies and working processes. This enables the management team to focus on creating a supportive environment in which people are able to do their best work.

For assessment, eNetAssess enables you to creating and manage bespoke tests in a secure environment. eNetAssess offers a complete eAssessment solution from test creation, question authoring, centre management, scheduling, authentication, invigilation and verification through to reporting and analysis.

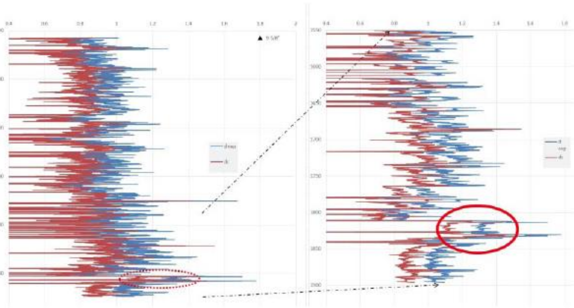
A cost effective approach to pore pressure detection using RT methods, a case study: verification of pre-drill model with onsite observations

Rudolf Knezevic, O. Knoop, A. Hollerer, Th. Kühn, A. Meledeth
OMV E&P

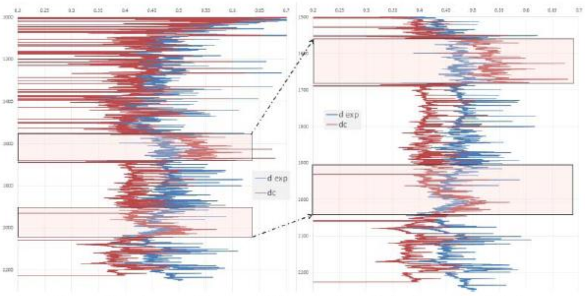
Given current tight budgetary frameworks, a modified approach to identify overpressures has been taken in this case study. Aside from the standard methods for pore pressure monitoring (LWD measurements - e.g. acoustic, resistivity, density), there are numerous observations which can be made by on-site personnel during drilling that can aid identification of impending overpressure zones. This paper/poster describes how a pore pressure model, built from relevant offset wells with the same overpressure, performs when established theories are applied to it. Each method is rated for this individual field with regard to the ability to establish a level of awareness when approaching a possible overpressure. This case study is based on two appraisal wells (one including an exploration leg) that were drilled into an over-pressured compartment that led to a well-control situation with significant NPT. From data analysis it can be assumed that the overpressure was ´visible´ approximately 100m above the actual kick-depth with increased significance of observations leading to expectation of overpressure up to 50m ahead of the actual kick-depth.

Knowledge of the field-related ´behavior´ when approaching an overpressure can help create a paradigm-catalogue to avoid well-control situations for a region/field when drilling similar wells during field-development phase.

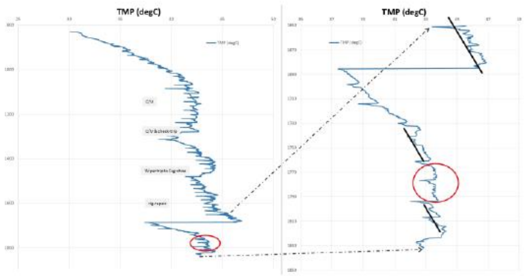
Example #1 for application of method comparison of RT data (left) with offline model (right):



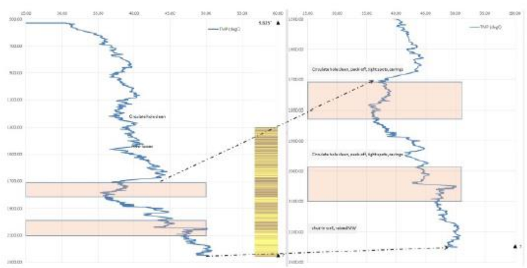
Dexp/Dc while drilling (overview left & zoom right)



Dexp/Dc from offset well (overview left & zoom right)



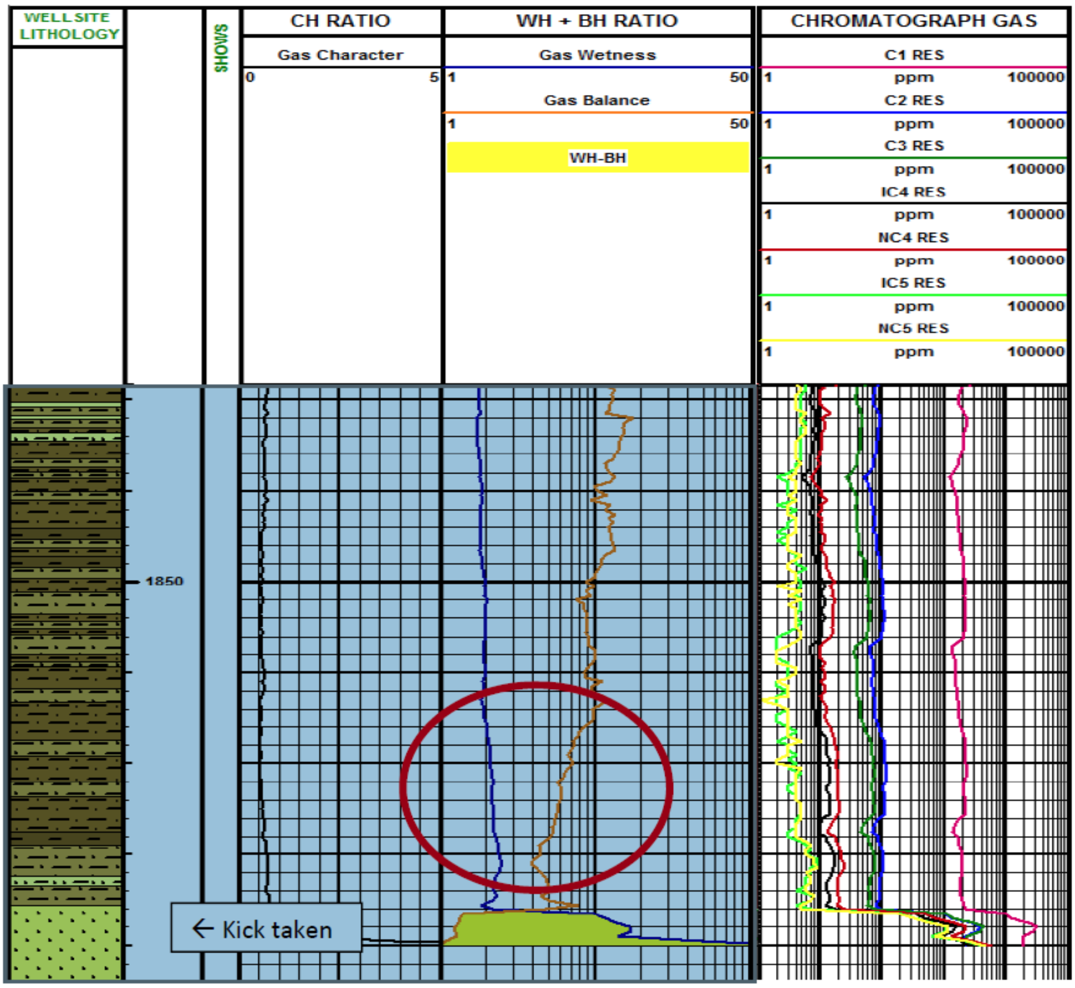
Temperature while drilling (overview left & zoom right)



Temperature from offset well (overview left & zoom right)

Example #2: Gas-Analysis (Wetness, Balance & Character) from recently drilled well: Theory behind Gas-Analysis of wetness is that as the gas migrates away from the source rocks then it becomes increasingly drier as the lighter gasses are more mobile and thus will travel further.

With this it is possible to identify a developing overpressure before drilling into a permeable layer generating a possible kick:



Offset well: Gas character / Wetness & Balance

Lessons learned on salt drilling in the Campos Basin Pre-salt projects and the importance of the geological knowledge of the salt

Munir Pinto Koosah; Antonio Mainieri Vieira Da Cunha
PETROBRAS Petróleo Brasileiro S.A

Drilling operations through salt zones have gained importance in Brazil due to the discovery of large oil and gas reserves in the Pre-Salt formations. In the Campos Basin, the Pre-Salt development is in the northeastern region. In this area, drilling through salt formation is very challenging mostly due to the high creep rate of the rocks in salt domes. In addition, the seismic has poor quality inside the domes and it’s very difficult to predict the position and thickness of each layer, despite the salt types are well-known.

The Salt Formation lies beneath a thick sedimentary column and, due to the depths where the evaporite layers occurs, the temperature creates a high creep rate of these rocks, mainly in salt domes. This creep creates a risk of packoffs and stuck pipes that can create a large amount of lost time to the company. The evaporite domes are formed mostly of halite, anhydrite, and less common carnallite, sylvinite and shales. The lithologies with highest mobility are carnallite, silvinite and, in a lower creep rate, halite. The prediction of the different salt types is important for well planning but it is very difficult to assure.

This difficulty happens due to poor seismic signal inside the dome, which makes it impossible to predict the sequence of the evaporitic layers. The thickness of the sedimentary layers beneath the salt, associated with high angle of the salt flanks and the seismic properties makes the seismic signal week, creating errors in the depth prediction of the layers. Besides that, the salt is mostly allochthonous and there is no way to correlate layers inside the domes. In some regions, it is possible to detect the base anhydrite layer, but most of the time it occurs in sub seismic resolution.

The two major problems that occur in the salt drilling in the area are the creep closure of the salt with a resulting packoff and stuck pipe, and the fluid loss that can occur when getting in the underneath reservoir. The stuck pipe problem was solved by increasing the mud weight for 13 or more ppg, in order to avoid the creep closure. The increase of mud weight was successful, and after that, only minor lost time was registered related to packoffs.

Drilling with high-density fluids to assure a minor salt creep was the solution to the stuck pipe problem, but in the other hand created a problem on the second main risk of the operation, which is to enter in the reservoir with a high differential pressure which can lead to fluid losses. The difficulties to predict the salt base in the seismic associated with fact that the salt base is very heterogeneous and no mobile rocks can be exposure with the reservoir creates the necessity to settle a casing shoe inside the basal anhydrite and assure that there will be no mobile salt exposed in the same drilling section with the reservoir. To do this, the reservoir top needs to be confirmed and the salt base lithologies need to be correctly interpreted, drilling as minimum as possible inside the reservoir section. The geological knowledge of the evaporite base and the carbonate top is a major issue to achieve this goal.

Because of the stuck pipe risk, the LWD tools used on the BHA are mostly Gamma Ray and Resistivity. There are charts available in the industry used to help identify different types of evaporites, but these charts use mostly GR associated with DT and Density logs. Unfortunately, only a few wells acquired DT and Density logs in the area. In addition, the chart data didn’t applied so well in the area. Besides that, the identification of drilling salt cuttings is difficult. The carnallite and sylvinite cuttings tend to dissolve easily on the drilling fluid, even in oil base muds, and most of the times the identification is done only by using logs.

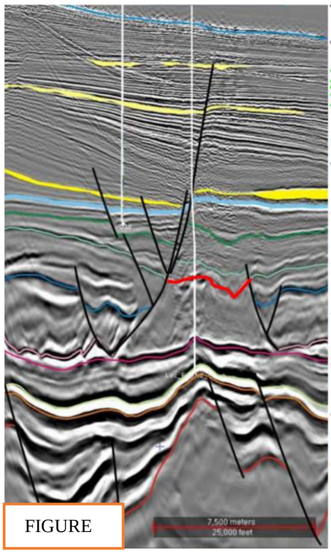
Acknowledging the need for more information, the field geologists started studying correlated salt basins and wells that have more data to help understand the compositional variations and to create a regional identification chart. It was observed that the anhydrite layers shows a particular resistivity signature when comparing to the adjacent salts that was not registered on the industry, and that the sylvinite and the carnallite salts did not match with the charts, because they usually occur mixed in the area, appearing as nodules inside the halite.

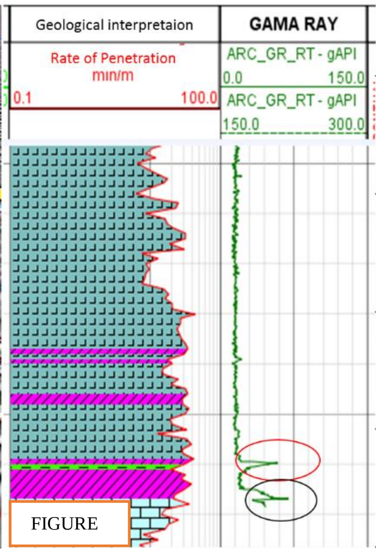
Over the last years was possible to acquire some sidewall corings of this section in two wells. The data acquired showed that there is a transition between the carbonates and the evaporite sequence. This transition helps to predict the reservoir top. The first appearance of carbonates in the evaporitic sequence occurs in most of the wells 20 meters above the reservoir. Therefore, the identification of carbonates in cuttings is very important and sample analysis in the microscope, in addition to HCl and Calcimetry tests are reliable and cheap methods to assure that.

The other data used to identify the transition is the occurrence of two GR marks. The first mark occurs inside de evaporitic sequence. It is generally a simple GR peak, geologically characterized by carbonates and/or shales, often anhydritized. This mark is named "O" Mark and it appears at maximum 10 meters above the reservoir top. The other mark is called "L", characterized by 3 to 10 GR peaks, usually equidistant and very similar to each other, characterized by laminites and subordinately grainstones and stromatolites.

To avoid the fluid loss to the formation and miss the top of the reservoir to production, it is important to drill as least as possible into the reservoir and assure that the well is stopped at the right depth. To guarantee that, the strategy is to use a GR tool as close to the bit as possible, drill with low ROP and correctly identify the lithologies.

This study shows that it is very important to understand the salt layers/domes behavior/composition and continue acquiring data to improve the drilling efficiency and to reach the reservoir under ideal conditions to avoid NPT.





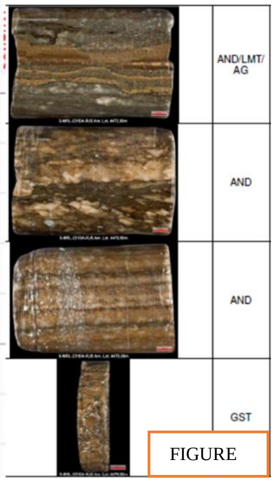


Figure 1: Seismic section showing the salt domes (top of the layer marked in red) and the lack of resolution inside the salt which makes correlation difficult.

Figure 2: Geologic interpretation from one of the wells showing the base anhydrite layer, the register of the "O" mark (red circle) inside the layer and the beginning of the register of the "L" mark (blue circle) close to the reservoir top.
Figure 3: Sidewall coring acquired on the basal anhydrite layer of the salt, note the presence of laminites (LMT), grainstones (GST) and shales that occur in the base of the evaporitic sequence (AND).

Zennor and the art of supplier governance

Jack Willis, David Baldwin, **Jaimin Jethwa**
one&zero, Zennor Petroleum

Introduction

What is the difference between buying a coffee and procuring downhole data acquisition services? Despite the claim by Starbucks that there are over 87,000 possible drink combinations in-store, purchasing a coffee is a relatively simple process. The information needed to make a decision is based on a small number of variables. There is little need for the end user to have a deep understanding of the coffee-making process, nor do we need to interact with the barista beyond the time it takes to process the order. Economists refer to these types of transactions as "arm's length", because no long-term relationship exists between the buyer and the supplier. In contrast, the purchasing of data acquisition services demands a close working relationship between the operator and the vendor to overcome the challenges presented by every new well. In complex transactions such as procuring data acquisition services, research has shown that "governance" of the relationship between the buyer and supplier can be a critical success factor (Gereffi, 2005). We explore the extent to which the governance of relationships between operator and vendor is performed in the planning phases of the drilling process in the North Sea. A case study describes a unique solution, co-created by Zennor Petroleum and one&zero for the Finlaggan development campaign, designed to address some of the deficiencies which currently exist in the preparation phases of M/LWD operations.

Evolution of the Supplier and Buyer in the UKCS

Since the first oil well was drilled in the UKCS in 1964 by Chevron, both the structure and population of operators and their service providers have evolved significantly. Driven by the change in asset materiality of the basin, as well as the expansion of the capabilities within the supply chain, the resulting new organisational structures have created new challenges. What was once the preserve of large monolithic organisations, dominated by the Seven Sisters, is now the playground of the smaller more dynamic operators seeking maximum economic recovery in complex areas such as brownfields. The international majors have consolidated their activities, focusing on core assets with the scale to support their internal cost structures. Whilst the average operator size has reduced in head count, the supply chain supporting exploration activities has grown rapidly over the same period. Lead times for new technologies to market have shrunk, and the breadth of technologies available for data acquisition continue to increase year-on-year. This combination of decrease in operator size and increase in service complexity demands innovative approaches to optimise the execution and management of exploration activities.

Governance of the buyer and supplier relationship

The planning and preparation phases of M/LWD operations in the North Sea appear well established after years of implementation. Following the selection of a service provider through a tender process which evaluates capabilities, resources, technology differentials and value, an extensive planning phase ensues. Yet, how much does the current interfacing between operator and the service provider really provide the necessary insights to give confidence that sufficient resources and capabilities are in place to deliver the agreed services?

It is often the case that audits of the supplier are not performed prior to award of a contract, with reliance placed on qualification schemes such as ISO and API Q2, or other supply chain risk management services such as FPAL. Although such certification standards provide assurances on Quality Management Systems (QMS) and core competencies, they do not provide the detail of information required to fully identify operational risk in relation to specific operations, or the resources available to perform operations to a high-level of service delivery for a specific project. Furthermore, once the operations plan is established it is usually left to the provider to locate, assign and prepare resources with little or no intervention from the operator.

Zennor – A new method of supplier governance

Zennor's Finlaggan prospect was appraised in 2016 with commercial viability confirmed by drill stem test of 21/5c-7Z in the same year. Despite the overall success of the drilling operations several issues were highlighted during the review phase. These centred around the lack of visibility on resource planning and general co-ordination of activities during the preparation phases which ultimately had an impact on operations.

In order to improve operations for the 2018 drilling campaign Zennor partnered with one&zero in order to establish a set of new QA/QC protocols delivered through an innovative cloud-based solution (WiPort™). Working with the supplier to understand the inner workings of their Quality Management System through audit and review formed the basis for an operational readiness and risk assessment. A mitigation plan to address any potential weaknesses in the supplier organisation at the local and regional level was then created. The mitigation plan was transformed into a series of metrics and quality checks to be measured and performed at pre-defined frequencies during the build up to operations. Information obtained through a mixture of qualitative and quantitative techniques including document analysis, sampling, and direct information requests were fed into the WiPort™ -cloud solution. This provided Zennor with real-time visibility on all elements of the preparation phase, specific details on each of their assigned assets to the subcomponent level, and an overview of pre-agreed quality metrics. Having this kind of previously unavailable information to hand informed the decision-making process, which ultimately impacted on how operations were planned in a number of ways which will be presented.

Burlington House
Fire Safety Information

If you hear the Alarm

Alarm Bells are situated throughout the building and will ring continuously for an evacuation. Do not stop to collect your personal belongings.

Leave the building via the nearest and safest exit or the exit that you are advised to by the Fire Marshal on that floor.

Fire Exits from the Geological Society Conference Rooms

Lower Library:
Exit via main reception onto Piccadilly, or via staff entrance onto the courtyard.
Lecture Theatre
Exit at front of theatre (by screen) onto Courtyard or via side door out to Piccadilly entrance or via the doors that link to the Lower Library and to the staff entrance.
Main Piccadilly Entrance
Straight out door and walk around to the Courtyard.

Close the doors when leaving a room. **DO NOT SWITCH OFF THE LIGHTS**.

Assemble in the Courtyard in front of the Royal Academy, outside the Royal Astronomical Society. Event organizers should report as soon as possible to the nearest Fire Marshal on whether all event participants have been safely evacuated.

Please do not re-enter the building except when you are advised that it is safe to do so by the Fire Brigade.

First Aid

All accidents should be reported to Reception and First Aid assistance will be provided if necessary.

Facilities

The ladies toilets are situated in the basement at the bottom of the staircase outside the Lecture Theatre.

The Gents toilets are situated on the ground floor in the corridor leading to the Arthur Holmes Room.

The cloakroom is located along the corridor to the Arthur Holmes Room.

Ground Floor Plan of the Geological Society, Burlington House, Piccadilly