Issue 30 \ April 2018

SPE International
London Section

SPEREVIEW LONDON

- Depth Control: Challenges and Practicalities
- Alain Gringarten on Well Test Analysis
- What has SPE London Done for Me?
- PLUS: Events, Jobs

Contents

ABOUT US
The Society of Petroleum Engineers (SPE) is a not-for-profit professional association whose members are engaged in energy resources, development and production. SPE serves more than 143,000 members in 141 countries worldwide. SPE is a key resource for technical knowledge related to the oil and gas exploration and production industry and provides services through its global events, publications, events, training courses and online resources at www.spe.org, as well as local chapters such as the SPE London section.
SPE London section publishes SPE Review London an online newsletter, 10 times a year, which is digitally sent to its 3000+ members. If you have read this issue and would like to join the SPE and receive your own copy of SPE Review London, as well as many other benefits – or you know a friend or colleague who would like to join – please visit www.spe.org for an application form.

CONTACTS
Communications: spelondon@spemail.org
CHANGE OF ADDRESS?
Please go to: https://www.spe.org/member/access/MyAccount

Information

At SPE Review London, we strive to provide knowledge and information to navigate our changing, and challenging, industry. We trust the April 2018 issue of SPE Review London will be useful, actionable and informative.

In the first of this issue's two technical features, '**Depth Control: Challenges and Practicalities**', **Veerle Steenhuisen, an M/LWD Field Engineer at Schlumberger,** discusses (page 4) how LWD depth measurements are being made, what the inaccuracies are that come with these measurements and how to possibly overcome these inaccuracies.

The second of this issue's technical features **'Alain Gringarten on Well Test Analysis'** starts on page 7, with an overview of his presentation to SPE London in March**.**

We have a new feature starting in this issue, where we ask: **'What has SPE Done for Me?** Read the insighful responses on page 6.

Our regular features include: Meet the people **'Behind the Scenes'**, The SPE Review Editorial Board (page 3) and the **SPE London Board** (page 10).

Join us for the London Section Tuesday evening meeting on 24 April, 2018 (see page 9 for booking information).

Make sure to keep up to date with **industry events and networking opportunities,** and the **Job Board** (thanks to Jared Hammond, Reservoir Engineer - Consultant, for providing the monthly job statistics)**,** all on page 11.

Get noticed in 2018 – write an article for SPE Review London, or **volunteer to speak at future events**. For more information, or to volunteer **contact Patrick Davies**, SPE London BD Chair (patrick.davies@gmail.com).

And don't forget to check out our social media pages: Facebook, Twitter, and Linkedin.

As always, this issue of SPE Review London offers the opportunity to be educated, entertained and informed.

http://london.spe.org/home

SPE International London Section

Behind the Scenes: SPE Review Editorial Board

Jonathan Ovens
Chief Editor

- Ph.D in Physics at Cambridge University.
- Joined Shell in 1986. Reservoir Engineer – hydraulic fracturing, pressure transient analysis and reservoir simulation.
- 1997 - 2012: independent consultant covering the North Sea, North Africa and the Middle East.
- Experience ranges from Exploration and Development planning through to Reserves Evaluation.
- 2013: Senior Reservoir Engineer at JX Nippon E&P (UK) Ltd.
- 2009 and 2015 served with SPE Europec Technical Committee.
- Member of the SPE London Board.

Josh Beinke
Editor

- Graduated from University of Adelaide with degree in Petroleum Engineering.
- 10 years prior experience with Chevron Corporation, Origin Energy and Santos, including as Production Engineer on the Gorgon Field during First Gas.
- Following move to Europe in 2016, consulted on European and African assets (specialising in data room and field development advisory).
- Now working out of Amsterdam as a Production/ Exploitation Engineer with Vermilion Energy.

Ffion Llwyd-Jones
Designer

- Editor and business writer, with 15+ years experience in North America and the UK.
- Editor for several trade and consumer magazines (print and/online).
- Provides industry-related case studies, and detailed, research-driven B2B reports and technical white papers.
- Accomplished photographer, and videographer.
- Educated in Canada, and in the UK.
- Fluent in Welsh and English.
- BA (Hons) from The Open University.

Depth Control: Challenges and Practicalities

Veerle Steenhuisen

Depth is very important for a correct formation evaluation and proper well placement, especially now we drill more and more challenging reservoirs. But how accurate are depth measurements while drilling? This article will give some insights in how depth is being tracked during LWD (logging while drilling).

September 2017 saw the largest gas discovery in the Dutch North Sea in the last 25 years, also known as the Ruby discovery. The Ruby well was the frst well drilled in this area in more than 20 years and all the formation evaluation (FE) measurements in offset wells were made only by Wireline. However, on this well both LWD and Wireline FE measurements were made, so the question was raised: What the best estimate was of true depth?

This project is just an example of the difficult situation we find ourselves in when measuring formation evaluation parameters: "How accurate are our FE measurements with respect to depth?" With longer and deeper wells, and increasingly thinner and more challenging reservoirs, this problem becomes more acute. The computation of reservoir characterisation parameters, such as net-to-gross or the correlation of geological units is relying on the accuracy of depth measurements. This means that a field might mistakenly not be developed if the depth measurements are inaccurate – or the other way around! This article will discuss how LWD depth measurements are being made, what the inaccuracies are that come with these measurements and how to possibly overcome these inaccuracies. Wireline depth measurements won't be discussed – however, please keep in mind that these measurements have their own inaccuracies.

All measurements made by the LWD tool are referenced to time, which means that for every measurement we know when it was taken. To know where each measurement was taken, we need to measure depth as a function of time and we need to know the wellbore location in space.

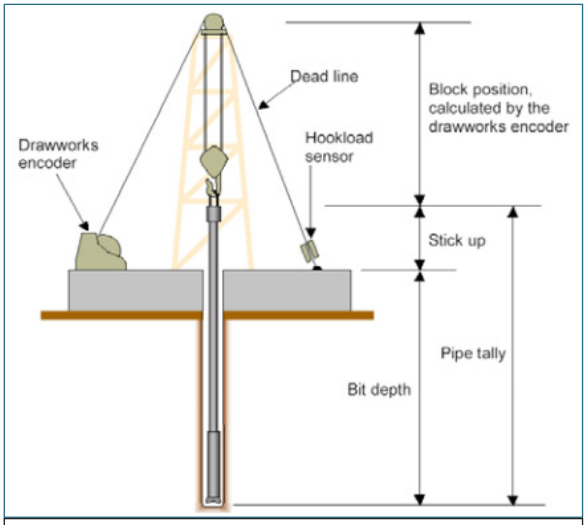


Figure 1: Major surface depth measurement elements

LWD depth measurements are referenced to driller's depth, which is the length of joint or pipe that is lowered into the well. Each pipe is measured on surface by hand and summed into a pipe tally. To determine how much of the last pipe is below the rotary table, the elevation of the travelling block is tracked at surface, using a geolograph or drawworks encoder (*Figure 1*).

For every distance the block travels, it is assumed that the bit travels an equal distance. Bit movement is only updated when the pipe is 'out of slips', which is measured on surface by a hookload sensor attached to the deadline. Additionally, on semi-submersibles one must also compensate for heave, swell and tidal movement. The LWD depth, which is measured by all these sensors, is periodically adjusted to match the driller's pipe tally. Finally, to refer the depth to a fixed datum, such as mean sea level for example, the elevation of the rotary table to the fixed datum must also be known.

There is already a possibility for error in each of these operations, e.g. the pipe could be measured wrongly on surface or surface sensors might not be calibrated properly. But even if all these operations are executed perfectly, the measured LWD depth will not equal the actual length of pipe in the hole. In a static downhole environment, the length of the pipe will be modified by the weight of the string itself, by thermal expansion of the metal and by the hydrostatic pressure of the mud column. If a kilometer of railroad track can expand tens of centimeters when heated, imagine what 5km of steel pipe does when subjected to an increase in temperature of more than 100 degrees Celsiua. On top of this, when the drilling fluid is circulating, additional elongation or shortening will occur due to the high pressure within the pipe and friction of the drilling fluid against the pipe wall. The fluid type and possible added pills or lubricants will affect this friction factor and may not be linear over the entire wellbore. Furthermore, when drilling, the

Continued on page 5

Depth Control: Challenges and Practicalities continued

varying weight-on-bit and additional friction of the pipe against the side of the borehole wall will cause the string to elongate or shorten and in some cases even buckling or drill pipe twists may occur.

As mentioned before, the wellbore location in space is another condition to go from measurements in time to measurements in depth. The accuracy of the wellbore profile depends on amongst others the number of surveys taken by the MWD tool, the accuracy of the surveys, the correctness of reference gravitational and magnetic data and the computational model of the wellbore profile based on these surveys. Finally, the time-measurement itself may be erroneous due to tool clock drift. The measurements made by the LWD tool are recorded by the LWD clock, whereas the depth measurements are based on surface time. If at the start of the LWD acquisition process, the clock time is not checked against the surface time and/or if the tool time and surface time start drifting, the conversion from when to where will also result in a wrong output.

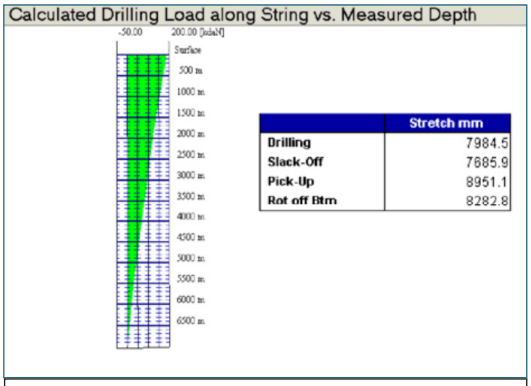


Figure 2: Drillpipe stretch for a vertical well under various rig operation modes

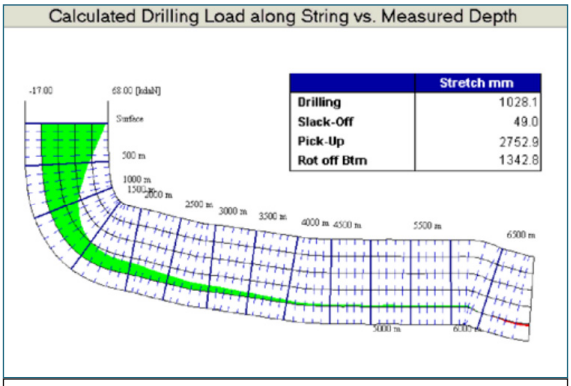


Figure 3: Drillpipe stretch for a horizontal well under various rig operation modes

Conclusively, the measurement of LWD depth comes with many inaccuracies. A computation from Dashevskiy et al.[1] shows the absolute drillpipe stretch for a 7000m long drillstring is 0.5 to 9m, depending on the rig operation mode and wellbore profile. The relative difference in stretched pipe length between these rig operation modes for a vertical wellbore profile is about 1 meter (*Figure 2*), whereas for a horizontal well this difference is even higher, namely about 2.7m (*Figure 3*).

Dashevskiy et al.1 and Chia et al.[1] came up with methods to improve the accuracy of LWD (and Wireline) logging depth. These methods include the use of industry standard Torque and Drag models and thermal expansion algorithms to compensate for mechanical stretch and thermal expansion. Case studies from Chia et al.[2] show, by comparing overlapping LWD and Wireline gamma-ray logs, that the LWD logging depth is significantly improved using this method. It would go too far to discuss these methods here in detail, so please refer to the mentioned papers for further information.

If we want to properly evaluate and develop more challenging reservoirs in the future, it would be advisable to invest time in the development and implementation of these methods or at least be aware of the inaccuracies that come with the measurement of LWD (and Wireline) depth.

[1] Dashevskiy, D., et al.: 'Dynamic Depth Correction to Reduce Depth Uncertainty and Improve MWD/LWD Log Quality' paper SPE 103094

[2] Chia, C.R., et al.: 'A New Method for Improving LWD Logging Depth' paper SPE 102175

Veerle studied Applied Earth Sciences and Applied Geophysics at ETH Zurich, RWTH Aachen and TU Delft. During her studies, she did several internships and since graduating she works as an LWD Field Engineer for Schlumberger all over Europe on both on- and offshore rigs.

WHAT HAS SPE LONDON DONE FOR ME?

The SPE is a global organisation of 88,000+ E&P industry professionals.
The SPE London board oversees the SPE London activities including our evening programme and other events. Our various committees have specific focus for the members including Young Professionals, Women in Energy and associated student chapters. As well as engineers who make up our core, we also welcome those with qualifications in geology, geophysics, earth science, environment, health and safety, mathematics, information technology, as well as management and economics.

Piers Johnson, OPC

"The SPE has been good, not only for me personally in a technical capacity, but also for my company Oilfield Production Consultants (OPC) Ltd, in helping develop business from the SPE community. The membership of the SPE is diverse both technically and geographically, and I have had the pleasure of being invited to make technical presentations internationally as well as locally in the London and Aberdeen. An SPE event, of any size or nature, is always an excellent place to meet like-minded fellow professionals both technically and socially."

"The SPE has given me multiple opportunities. Early in my career I was given responsibility and gained experience in being a member of and also chairing the SPE London Section committee. It helped expand my professional network through finding speakers and attendees for the continuing education seminars and attending meetings. To plan successful seminars, I kept abreast of technology and topics that were relevant to the London audience, improved my marketing skills (mainly powers of persuasion) and made a healthy profit for the section. After many years in the London section committee, I became a non-executive director for SPE Europe, another great learning experience. As the SPE is a global organisation, I have met and made friends with members all over the world and have helped set up a new SPE section in Namibia. I'm also very proud of helping to promote the 'Women in Energy' seminars in their early years."

Clara Altobell (former Chair)

Richa, Chair Elect

"Being part of SPE London has provided me great opportunity to connect with like-minded people in Energy sector. Volunteering with the section has broadened my skills - it provided me an opportunity to work on my Leadership skills while getting connected with other volunteers. Attending various meetings by the section, I not only learned about technical and non-technical topics pertaining to the industry but also met energy professionals from all across the energy sectors."

Alain Gringarten on Well Test Analysis


Alain Gringarten

At the SPE Meeting held at Imperial College on Tuesday 27th, Professor Alain Gringarten presented a lecture on the history of well testing. This article provides a summary of his long experience in well test analysis, from the potentially deceptive simplicity of the Horner straight line, to the mathematical subtlety of multi well deconvolution. Full slides from the presentation may be found on the SPE website.

Well test analysis is used to assess well condition and obtain reservoir parameters. The evolution of well test analysis techniques over the years is illustrated in *Figure 1*. Major improvements have occurred approximately 13 to 19 years apart, driven by the availability of both new types of data and new mathematical tools. Early inter pretation methods (by use of straight lines or log-log pressure plots) were limited to the estimation of well performance.

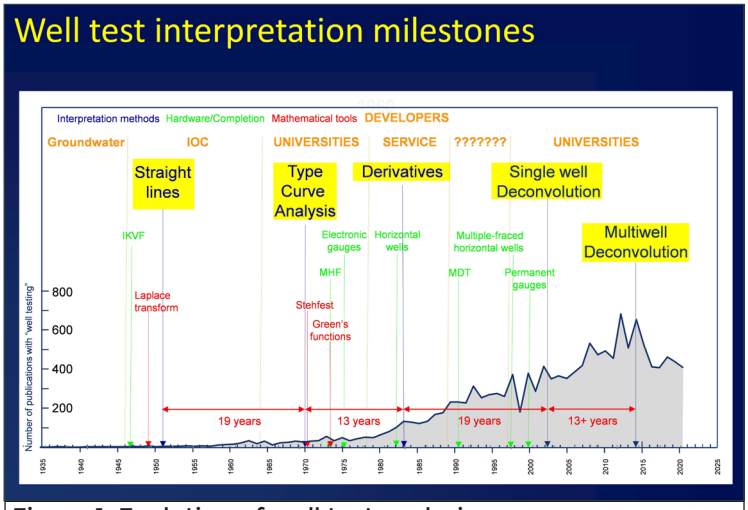


Figure 1: Evolution of well test analysis

Well test analysis has become a very powerful tool for reservoir characterisation, following:

- the formulation of an integrated methodology in the early 1980s,
- the introduction of pressure-derivative analysis in 1983,
- the development of complex interpretation models able to account for detailed geological features,
- the derivation of a stable deconvolution algorithm in the early 2000's,
- and its successful extension to multiple interfering wells in our previous JIPs (2008-2018).

Although not strategically driven, progress in well test analysis techniques has essentially resulted in a significant increased capability for:

- identifying an applicable interpretation model and
- verifying the consistency of that interpretation model, as illustrated in *Figure 2*.

WTA Value = Identification + Verification

	ANALYSIS METHOD	IDENTIFICATION	VERIFICATION
50's	Straight lines	Poor	None
70's	Pressure Type Curves	Fair (limited)	Fair to Good
80's	Pressure Derivative	Very Good	Very Good
00's	Deconvolution	Much better	Same as derivative
10's	Multiwell deconvolution	>>	>>
	NEXT ?	>>>	>>>

Figure 2: Evolution of well test analysis capability

As a result, the amount of information that one can extract from well test data and more importantly, the confidence in that information, has increased significantly.

Figure 2 also suggests that any new improvement will have to further enhance the ability to identify and verify the well test interpretation model, and provide additional information.

How to achieve this has always been difficult to predict, but, following the development of multiwell deconvolution, using richer signals and mining the huge amount of well data available is a most likely direction.

Multiwell Deconvolution

The advantages of multiwell deconvolution are illustrated in *Figure 3* for a group of eight interfering wells (six

Continued on page 8

Alain Gringarten on Well Test Analysis continued

producers and two injectors) in a North Sea field[1] (*Figure 4*). Figure 3 compares data available for interpreting the pressure behaviour of one well (P13) using (1) conventional interpretation techniques (log-log analysis of build up pressure and derivative data); (2) single well deconvolution; and (3) multiwell deconvolution.

Conventional analysis is not capable to "see" beyond available drawdown or build up durations (about 15 hours in this case). Deconvolution converts pressure at variable rate into a single drawdown at constant rate, with a duration equal to the duration of the test (from the start of the rate history to the end of the pressure data being deconvolved). In this North Sea example, the deconvolved drawdown has a duration of 15,000 hours, a gain of 3 log cycles.

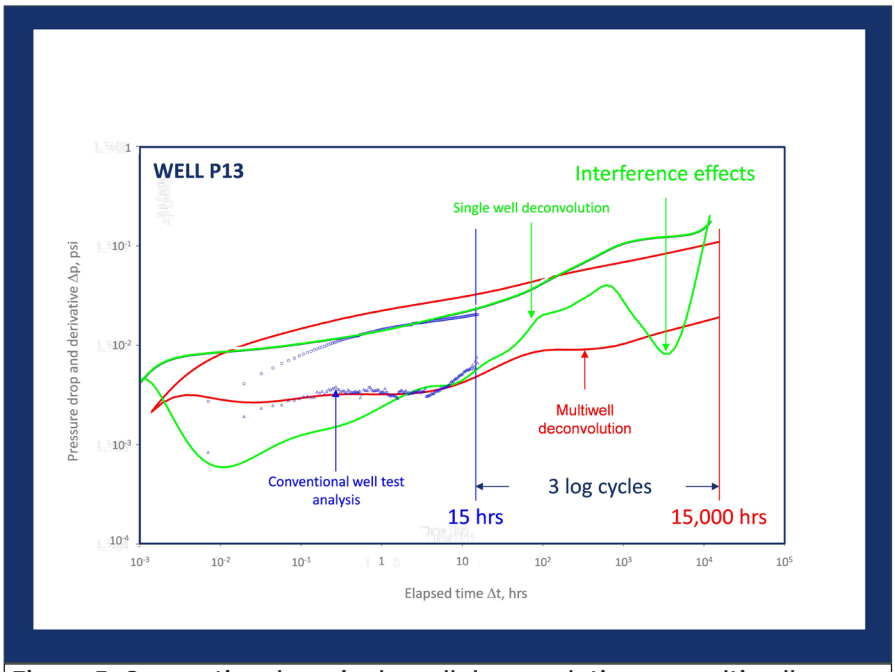


Figure 3: Conventional vs. single well deconvolution vs. multiwell deconvolution

Single well deconvolution, however, is impaired by interference effects, which make it unusable. Attempts to find a well in isolated conditions (well producing while all interfering wells are shut or vice-versa) proved futile.

Only multiwell deconvolution is able to determine the true well signature, i.e. as if the well were alone in the reservoir. The multiwell deconvolved derivative for well P13 suggests that the well is in a channel with increasing width, which is consistent with the faults identified from seismic.

The multiwell deconvolved derivatives obtained at the same time for all the other seven wells, and the interwell interference derivatives yield the sealing and leaky faults shown in *Figure 5*.

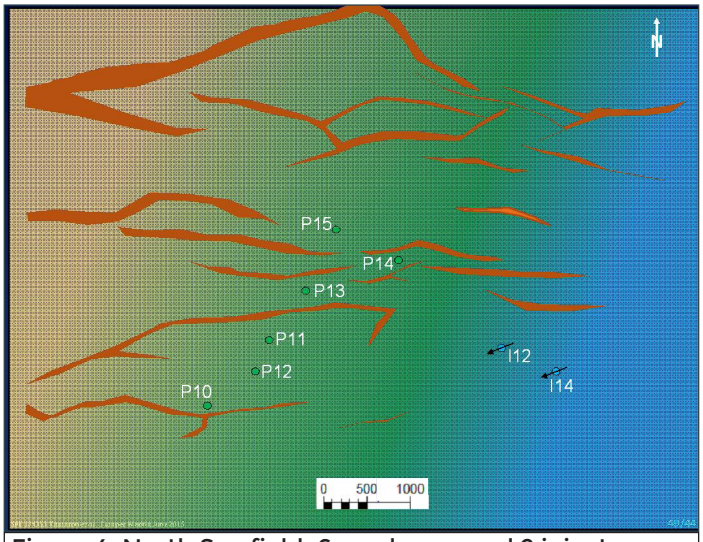


Figure 4: North Sea field: 6 producers and 2 injectors

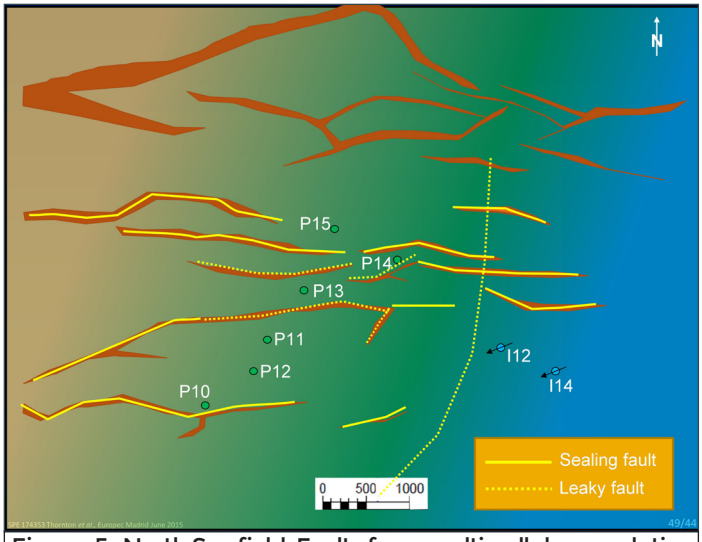
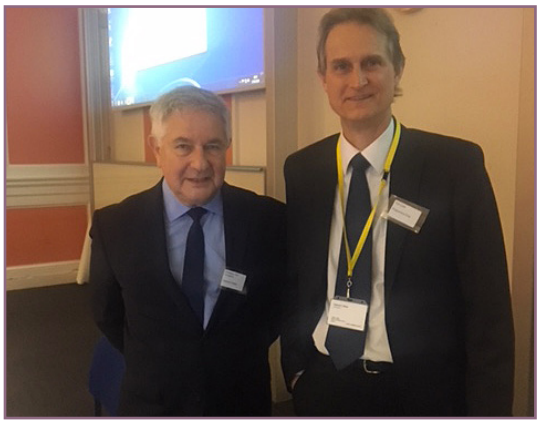


Figure 5: North Sea field: Faults from multiwell deconvolution

[1] Thornton, E. J., Mazloom, J., Gringarten, A. C. and Cumming, J. A.: "Application of Multiple Well Deconvolution Method in a North Sea Field" SPE paper 174353 presented at SPE Europec/EAGE Annual Conference, Madrid, Spain, 1-4 June 2015.

Professor Alain C. Gringarten is Emeritus professor of petroleum engineering and Senior Research Investigator at Imperial College London. A recognized expert in well test analysis, he has over one hundred publications and received several SPE awards (2009 North Sea Regional Service; 2004 Cedric K. Ferguson certificate; 2003 John Franklin Carll award; and 2001 SPE Formation Evaluation). A SPE member since 1969, he was elected a Distinguished member in 2002, a Honorary member in 2009 and was a 2003-2004 Distinguished Lecturer. He holds petroleum engineering MSc and PhD degrees from Stanford University; and an engineering degree from Ecole Centrale Paris, France.



Alain Gringarten and Tim Lines.

Anne Valentine (Distinguished Lecturer).

Networking session at an SPE London Business development event

Alan Gringarten answers questions from a packed audience.

Join us for the London Section evening meeting on 24 April, 2018

SPE International
London Section

AGENDA

5.00pm-6.30pm	**How new technologies are changing the oil and gas industry.** *Jeff Parkes, BP Subsurface Centre* This talk is about how new technologies are changing the oil & gas industry, and particularly how the digital transformation is impacting us. 'Digital transformation' as a term is rather over-used, and oil & gas is characterised as a digital laggard. I'll be discussing whether and how the subsurface is digitally transforming.
6.30pm-7.15pm	DRINKS AND NETWORKING BUFFET
7.15pm-8.45pm	**Petroleum Unitisation: how to do better.** *Paul Worthington, Park Royd P&P* Most petroleum unitisations are flawed, a state of affairs that leads to disruptive problems during the life of a straddling field. Yet, many of these difficulties can be averted. This presentation brings out ways of doing that so that unitisation is rendered more equitable. The key is to follow certain ground rules that have often been ignored. This message is reinforced through pertinent examples.

- **Venue:**

The event will be held at the Department of Earth Science and Engineering, Imperial College London. ***Map available here.***

- **Directions**:

Please note the main entrance to the Department is via the Royal School of Mines Building on Prince Consort Road, between 10 and 12 on the campus map.

- **Booking:**

All booking must be paid in advance and online please.
Book via Eventbrite
Email: katespe@aol.com

- **Cost:**

£34 for SPE/PESGB/EI members, £44 non-members,
£19 unemployed members. Non refundable.
£5 for students booking by Friday 20 April (£19 after).
All tickets have an additional Eventbrite fee.

Meet the SPE London Board

SPE is a non-profit professional society with 164,000 members in 143 countries. SPE London Section, with average 2000 members and seven associated student chapters, is an active section with an aim to connect, engage and promote exchange of knowledge within London energy community of technical and commercial professionals. The SPE London Board is the policy-making and governing body consisting of volunteers who devote their time to oversee many of SPE London's administrative and operating responsibilities.

Carolina Coll
Chair

Richa
Chair Elect

Miles Cudmore
Past Chair

Olga Bradulina
Secretary/Comms Co-chair

Cleone Butler
Treasurer

Maxim Kotenev
Comms Co-Chair

Tim Lines
Programme Chair

Adrian Southworth
Sponsorship

Adam Borushek
Cont. Education Co-chair

Patrick Davies
Cont. Education Co-Chair

Isabel Asenjo
Women in Energy Chair

Kanad Kulkarni,
Student Chapters Liaison

Abrar Pewekar
Young Professional Chair

Jonathan Ovens
Director, Editor SPE Review

Anthony Perry
Director

Arnaud Mille
Long Term Planning

Alain Gringarten
Director

EVENTS: Upcoming events 2018

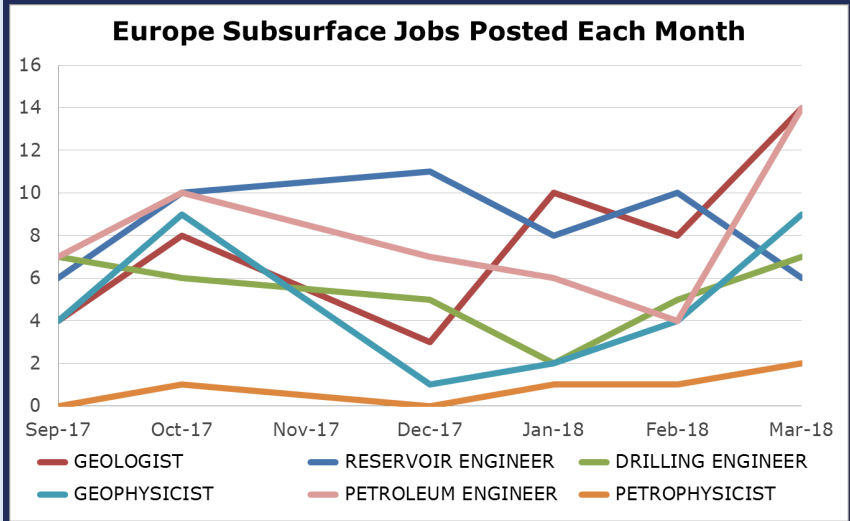
30 April - 3 May 2018 **(Houston, Texas)**
The Offshore Technology Conference
OTC is the largest global event for the oil and gas sector, it boasts more than 500,000 sq. ft of exhibit space, 70,000+ industry professionals, 2,000+ leading exhibitors, 300+ journalists, and over 100 speakers from around the world.
For more information, and to register: https://bit.ly/2rzPsP2

13-15 May 2018 **(Abu Dhabi, UAE)**
RDPetro – Research & Development Petroleum Conference and Exhibition
Welcome to RDPETRO 2018, the world's largest gathering focused on research and technology development for the oil and gas industry.
This event fosters closer collaboration across the oil and gas industry, technology innovators, start-ups and academia, to scout, source and award funding to innovative solutions that unlock and optimize oil and gas resources and create value.
For more information, and to register: http://bit.ly/2p3gQk2

11-14 June 2018 **(Copenhagen, Denmark)**
SPE Europec featured at 80th EAGE Conference and Exhibition
The theme this year is Opportunities Presented by the Energy Transition. Attended by more than 6,000 people from almost 100 coutries annually, this three-day conference will feature 1,000 technical oral and poster presentations, training courses, and workshops. In addition, key sessions will be held for students, young professionals, and women in the geoscience and engineering industry. The exhibition will showcase the latest developments in geophysics, geology and reservoir/petroleum engineering from 350 companies, allowing attendees the opportunity to enhance their product knowledge, interact with cutting-edge technologies, and meet the people behind the products.
For more information, and to register: http://bit.ly/2G9C4DE

18-19 June 2018 **(Aberdeen, Scotland)**
The SPE International Oilfield Corrosion Conference and Exhibition
The SPE International Oilfield Corrosion Conference and Exhibition, themed Asset Integrity Management in an Age of Uncertainty, will address both familiar and new challenges that come with the wide spectrum of requirements for effective corrosion management throughout an asset's lifecycle.
For more information, and to register: http://bit.ly/2nUVyp8

PETROLEUM SUBSURFACE JOBS - EUROPE



Selected Live Jobs at Print

Senior Geoscientist
London, UK

Drilling Engineer
Aberdeen, UK

Senior Reservoir Engineer
Oslo, Norway

SME Petroleum Geologist / Reservoir Engi
Delft, Netherlands

Jobs & Statistics Thanks to
www.oneoiljobsearch.com