London Petrophysical Society

Petrophysics 101: Core Concepts in Petrophysics

Thursday 4th September 2025
Geological Society, Burlington House, London
09:00-17:00 GMT

London Petrophysical Society - "Petrophysics 101: Core Concepts in Petrophysics" - Thursday 4th September 2025				
Start Time	End Time	Name	Company	Talk Title
09:00	09:30	Doors Open and Registration		
09:30	09:40	Martin Leonard	LPS	LPS Seminars - Introduction
09:40	10:15	Mike Millar	Independent	Water Saturation from Open-hole Logs
10:15	10:50	Andrew Foulds	Islay Subsurface & Petrafiz Ltd.	Why Core?
10:50	11:25	Trond Rolfsvåg	Hydrophilic	Petrophysical Sensemaking
11:25	11:50	Break		
11:50	12:25	Khalil Nourafkan	CalEnergy Resources	Uncertainty Propagation: From Well Logs to Reservoir Models
12:25	13:00	Harald Bolt	DwpD Ltd., Depth Solutions	Applying Uncertainty – Well Depth and Subsurface 3D Position
13:00	14:00	Lunch		
14:00	14:35	Iain Whyte	Tullow Oil	Petrophysics; "Interpreting wiggles for oil"
14:35	15:10	Jules Read	Premier Corex	Introduction to saturation height modelling from core data
15:10	15:35	Break		
15:35	16:10	Maciej Kozlowski	Halliburton	Improving Geothermal Reservoir Assessment Through NMR Log Calibration with Core Data
16:10	16:45	Adrian Leech	GAIA Earth Group	Operations Petrophysics and Log Quality Control (LQC)
16:45	17:00	Philip Gibbons	LPS	LPS President - Closing Remarks
17:00	Networking Reception in the Library			

Register via the LPS website: https://lps.org.uk/events/

Water Saturation from Open-hole Logs

Mike Millar; Independant

One of the main jobs of a petrophysicist is to provide data to determine hydrocarbons in-place. Using open-hole logs, the petrophysicist can determine lithologies, reservoir thickness, net-to-gross ratio, porosity, fluid types and contacts and water saturation.

Water saturation (Sw) is the proportion of the rock void space (porosity) that is filled with water, and the assumption is made that hydrocarbon saturation is 1 - Sw. Water saturation can generally be determined with accuracy from open-hole logs, provided the appropriate techniques and evaluation parameters are used.

Sediments in the subsurface are generally assumed to be water bearing, and during hydrocarbon migration, some of this water is displaced by oil or gas. Formation resistivity logs are frequently used to determine Sw, as there is a distinct contrast between sediments containing conductive salty formation water alone, and those containing a mixture of conductive formation water and non-conductive hydrocarbons. Using two empirical equations, Archie (1942) was able to quantify this contrast, and these form the basis for most of the Sw evaluations done today.

As open-hole logs are frequently the only safe and cost effective way of collecting accurate borehole data across the entire reservoir interval, the focus of this talk will be on techniques for calculating Sw from logs. We will show how to use the Archie equations and indicate some to the circumstances where they don't work and what might be done in their place. Mention will also be made of other logging techniques which give insight into water saturation.

Archie, G.E. (1942). "The electrical resistivity log as an aid in determining some reservoir characteristics". Petroleum Transactions of AIME 146: 54–62.

Worthington, P. F. (2000), Recognition and evaluation of low-resistivity pay, Petroleum Geoscience, 6, 77-92.

Mike Millar *is a retired petrophysicist, who spent more than 39 years working on exploration and development projects across the world. He has worked for a number of companies including Esso, BakerHughes, PetroCanada, and BG Group. His roles have covered everything concerning logs, pressures and cores from tendering for services, programme design and implementation, data quality assurance through to evaluations and input to static and dynamic models.*

Mike has served on the LPS committee in the roles of secretary, treasurer, and president. He was on the organising committee of the SPWLA 2018 symposium held in London, and presented the one-day workshop on Log Quality Control at the Symposium. In 2022 he was given the Award for Meritorious Service by the SPWLA in recognition of his outstanding service to the Society.

Why Core?

Andrew Foulds; Islay Subsurface and Petrafiz Ltd

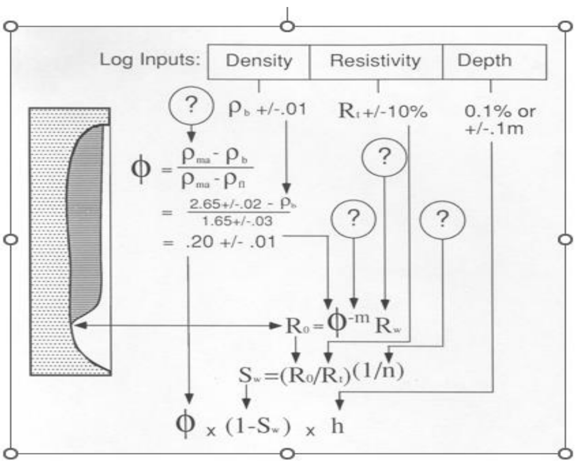
The reservoir is the ultimate source of revenue for any upstream project. Accurate analysis of both the in-place volume and the production performance is critical in assessing project revenue and in optimizing project development decisions

Core analysis is fundamental to effective reservoir management. The performance of a reservoir is mainly controlled by the rock and fluid properties and how both vary in space and time. Cores provide basic building blocks for reservoir characterization as the only physical elements of the rock that are available for direct examination. Core data is the foundation and indispensable part of the reservoir characterization process Core reduces uncertainty, especially when it is taken early in the development/production cycle. Critical geoscience/petrophysical data is only obtainable from core

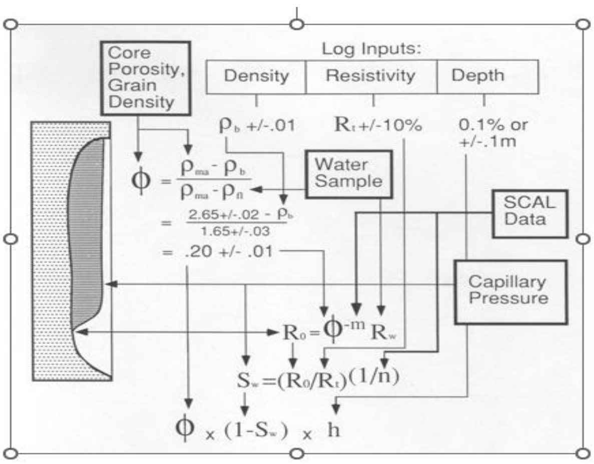
There are multiple needs for data from cores, from not just geoscience and petrophysics perspective, but also from a reservoir, production and drilling engineering viewpoint; all requiring certain data that needs to be gathered at different stages in the core analysis process. Alternatives to core include ditch cuttings, percussion and or mechanical sidewall cores; but all these sources can only provide limited material with other issues. However, it must not be forgotten that in the early days of the unconventional shale source rock play evaluation, ditch cuttings played a critical role in the screening and baseline evaluation of these difficult reservoirs.

However, any core program needs to be designed that will initially consider VOI, especially from a financial perspective, and any subsequent analysis program should be designed which takes into consideration the needs of all disciplines – do not underestimate your responsibility. There are a number of stages for any core analysis programs and effective communication between the stakeholders, end uses and more importantly, regular communication with the selected laboratory, will allow effect core programs to be efficiently designed and implemented. There are a number of experience core analysis practitioners who can help design, monitor and QC the results from these programs.

Formation evaluation core data acquisition programs are not just for Xmas – we have to look at the long-term implications and the short-term return on the data, i.e. quick K/PHI data is only a small dataset that can be derived from such an important data source medium. Core analysis is not the panacea for all ills but combined with focused LWD and or WL programs; uncertainties in the reservoir evaluation can be minimized to acceptable level.



Without core



With core

Andrew Foulds *is presently working in the UK as a Consultant Petrophysicist within his own company Petrafiz Limited as well as advising Islay Subsurface as a Principle Petrophysicist. He has over 45 years' experience in a number of disciplines within formation evaluation. He specializes in difficult formation evaluation problems, designing cost effective data acquisition programs and subsequent detailed analysis routines. Andrew previously worked for ExxonMobil in a number staff positions around the world, as well as a consultant in the London office. Previous to this he ran his own petrophysical consultancy for a number of years, as well as staff positions at a number of UK based oil companies and with a number of geoscience service companies. He holds a BSc in Geology from Hull University (1979). Andrew is an active member of SPWLA, and the Geological Society of London, and previously has held positions on the committee of the London Petrophysical Society as Treasurer, as well as an Editor of the society's magazine, DiaLog.*

Petrophysical Sensemaking

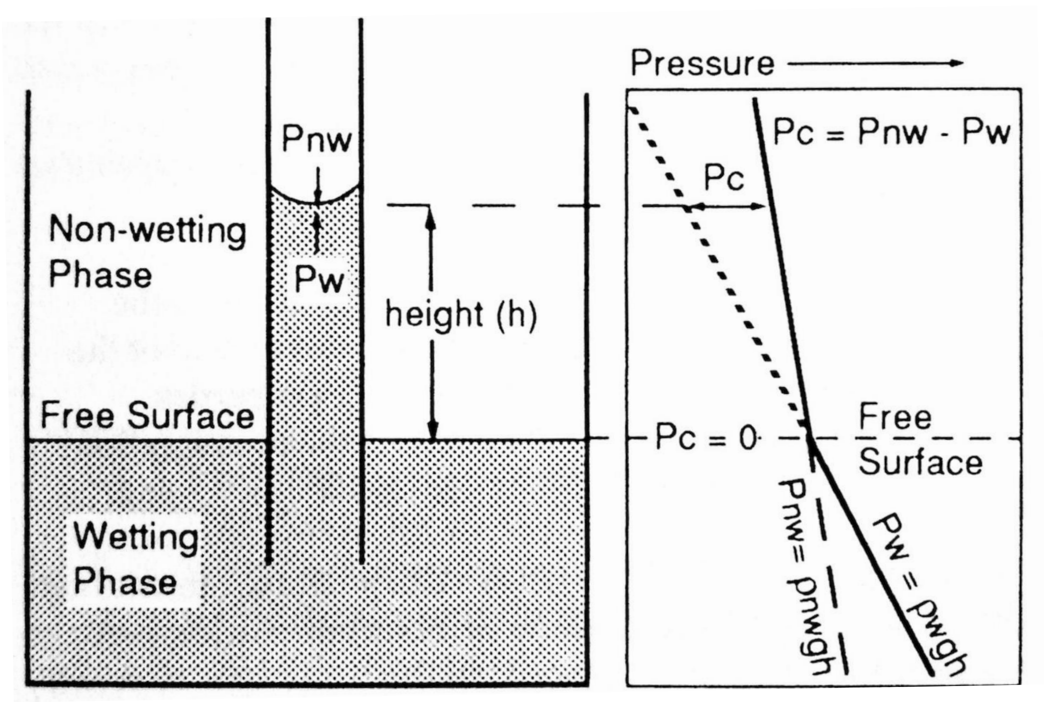
Trond Rolfsvåg; Hydrophilic

The objective of the presentation is to reveal logical inconsistencies at the core of Petrophysics, and how these logical inconsistencies have confused subsurface professionals in the past and still threaten future technological progress.

The presentation will show examples of how schoolbooks and technical textbooks defines the so-called "capillary pressure" in a way that are not logically consistent. These inconsistencies have obscured what interplay is really going on between water, rocks and hydrocarbons in the subsurface.

A correct physical understanding makes it easier to understand the reservoir situation so decisions can be made with more confidence. If the physical understanding is cluttered with inconsistencies technological improvements will be much harder to achieve.

The improved physical understanding of how pressure of hydrocarbons and water are equilibrating across a reservoir mandate that some of the old nomenclature should be refined.



This illustration contains several misleading content elements. Can you spot them?

__Trond Rolfsvåg__ is a Reservoir Engineer and the CEO of Hydrophilic. He holds a master's degree in petroleum technology from the University of Stavanger (UiS). With over 30 years of experience working for leading integrated oil companies, Trond brings a wealth of industry knowledge and expertise. In 2016, he founded Hydrophilic with the goal of developing innovative tools to enhance efficiency and sustainability in the exploration and production (E&P) industry.

Uncertainty Propagation: From Well Logs to Reservoir Models

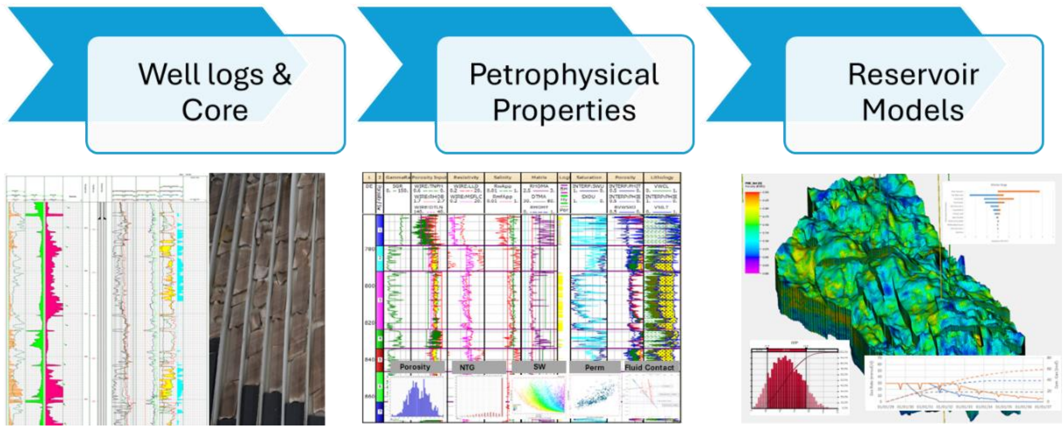
Dr. Khalil Nourafkan; CalEnergy Resources

In subsurface workflows, well logs and core data offer essential data for constructing static reservoir models. However, the inherent uncertainties in petrophysical interpretation—arising from tool limitations, borehole conditions, measurement errors, and interpretational variability—often go unnoticed and can influence the geomodelling process, affecting volumetric calculations, reservoir connectivity, and ultimately field development decisions.

This presentation explores practical strategies for recognising, quantifying, and mitigating uncertainty as petrophysical data progresses from logs and cores to reservoir models. Using real-world examples, we examine how variations in porosity, permeability, and water saturation interpretations influence facies modelling, property distribution, and static model realisations. Focus is given to:

- **Sources of Uncertainty**: Borehole environment effects, tool artefacts, and parameter selection during log analysis.
- **Upscaling Challenges**: Translating fine-scale petrophysical measurements to coarser model grid cells without losing geological realism.
- **Uncertainty Quantification**: Methods for capturing ranges in petrophysical properties and their volumetric implications.
- **Integration with Static and Dynamic Models**: How to ensure uncertainty awareness throughout multidisciplinary workflows and its effect on production forecasting.

The talk will also cover advances in digital workflows applications for managing uncertainty. By highlighting lessons learned from multidisciplinary projects in both conventional and unconventional reservoirs, it emphasises the critical importance of integrating petrophysics with geological understanding to deliver more robust, decision-ready reservoir models.



__Dr. Nourafkan__ is a Principal Geologist and Geomodeller with over 25 years of experience in subsurface characterisation and reservoir modelling. He has worked across diverse geological settings in the Middle East, Europe, Caspian, Australia, and Africa, focusing on integrating petrophysics, geology, and geophysics to enhance static and dynamic model quality. Dr. Nourafkan has led multidisciplinary teams in delivering field development plans and has a particular interest in uncertainty quantification and digital transformation in subsurface workflows.

Applying Uncertainty – Well Depth and Subsurface 3D Position

Harald Bolt; DwpD Ltd., Depth Solutions

Accurate well and Vertical depth measurement is a cornerstone of wellbore petrophysics. However, these positional data are inherently uncertain due to multiple contributing factors including measurement process and calibration, correction, model-fit (the ability of available data to support the modelled trajectory), and fixed positional accuracies (*ToolJointError*). These individual uncertainties accumulate along the wellbore, giving rise to three-dimensional (3D) positional uncertainty—including Vertical depth uncertainty—that influences all aspects of subsurface interpretation and modelling.

Understanding the basics of uncertainty is essential for QC'ing log data, integrating core and well results, and defining critical subsurface properties such as geological horizon placement, net pay, reservoir boundaries, and fluid contacts and gradients. For early-career professionals, appreciating depth-related uncertainties leads to better-quality subsurface positioning of log data, improved model inputs, and more robust hydrocarbon volume estimates. Driller's Way-point Depth (DwpD) enhances wellbore depth measurement by introducing a robust approach with defined accuracy management, thereby allowing wellbore depth uncertainties to be actively managed. 3D Way-point with integrated DwpD provides quantified 3D positional uncertainty, enabling tool and log subsurface positions to be referenced to defined spatial uncertainties. This is fundamental to reliable log and subsurface operations, improving confidence in subsurface characterization.

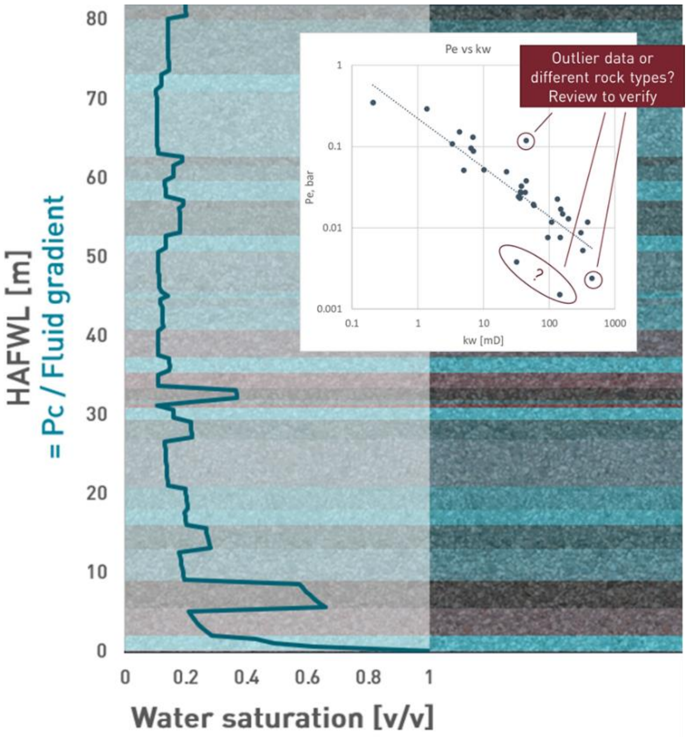
DwpD and 3D Way-point uncertainties are introduced and explained, including pointers on actively managing accuracy. This improves the correlation and validity of petrophysical analysis and the reliability of reservoir evaluation. An illustrative case example supports the presented methods. The discussion will conclude with an overview of uncertainty requirements as a foundation for effective data quality management

***Harald Bolt** has evolved from a logging engineer in the 80's to a world recognized expert in well depth determination and 3D positional uncertainty. He has a patent for the Driller's Way-point Depth process which describes the measurement of drill pipe depth and has a patent applied for 3D Way-point which describes subsurface 3D positioning and positional uncertainty. He is one of the few people in our industry able to create added value to our subsurface assets by describing with authority how well depth and position affects our subsurface business and what can be done to improve it. He is a member of LPS, DPS, SPWLA, SPE, ISCWSA, EAGE, and PESGB.*

Introduction to saturation height modelling from core data

Jules Read; Premier Corex

Core analysis has been described as the foundation of reservoir evaluation, since measurements can be performed directly on the reservoir rock material under controlled conditions with known properties of the samples and fluids being analysed. Building saturation height models from capillary pressure data derived from special core analysis programmes should give additional support and confidence to static model outputs.



However, there yet may remain some uncertainties within the core analysis data and it is good practice to review any received data, compile, cross-plot, correlate, QC and potentially re-interpret before correlating and inputting to the reservoir model. This presentation will present a core-based approach to building saturation height models including these QC & interpretation steps of core data and showing a couple of potential approaches for the mathematical description of capillary pressure data for input to reservoir models.

Jules Read *has approx. 35 years' experience in core analysis. He is co-author of two books: Advanced Core Measurements "Best Practices" for Low Reservoir Quality Chalk (2014) and Core Analysis - A Best Practice Guide (2015) and has authored/co-authored a number of published papers. He is former president of the Society of Core Analysts (SCA), a member its Technical Committee and peer reviewer for a number of scientific journals (SPERE, Petrophysics, TiPM). His main specialisations have been in wettability, capillary pressure and dynamic processes; including relative permeability, enhanced recovery systems and carbon capture, utilisation and storage.*

Improving Geothermal Reservoir Assessment Through NMR Log Calibration with Core Data

Maciej Kozlowski; Halliburton, Joost van den Broek, Milan Brussée; EBNv

Nuclear Magnetic Resonance (NMR) logging is a critical tool in the exploration and characterization of geothermal reservoirs, offering unique insights into subsurface petrophysical properties. Unlike conventional logging methods, NMR provides direct measurements related to pore fluid behavior and pore structure, enabling estimation of key parameters such as irreducible water saturation, permeability, and pore size distribution. These parameters are essential for assessing fluid mobility, reservoir quality, and long-term geothermal production potential. However, to fully leverage the potential of NMR data, especially in complex lithologies encountered in geothermal settings, proper calibration to laboratory measurements is indispensable.

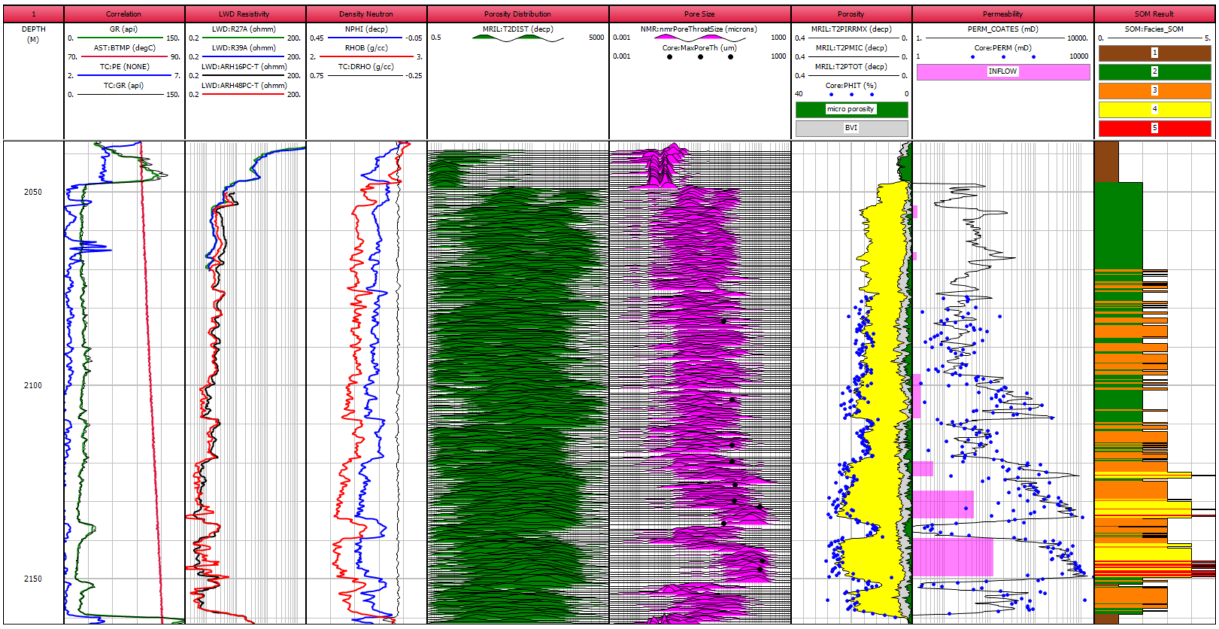
This study presents a comprehensive workflow for calibrating NMR log data to laboratory-derived petrophysical parameters, with the objective of improving reservoir evaluation accuracy. The calibration begins with aligning NMR-derived total porosity with core-measured porosity data, ensuring consistency between downhole and laboratory observations. Subsequently, permeability estimation from NMR data is refined through calibration with laboratory-measured core permeability, applying a empirical models of Coates equations, adjusted for formation-specific characteristics.

An important component of the workflow involves revising the default NMR cut-offs used to differentiate bound volume irreducible (BVI) and free fluid index (FFI). T2 cut-off is adjusted based on core NMR measurements.

Finally, NMR T2 distribution data are calibrated against Mercury Injection Capillary Pressure (MICP) measurements to establish a relationship between T2 relaxation times and pore throat sizes. This calibration enables a more accurate interpretation of the pore size distribution and connectivity, which are essential for predicting fluid flow and reservoir deliverability in geothermal systems.

The results are validated by production logging results from the injection test.

The proposed workflow underscores the importance of integrating NMR logs with laboratory measurements to enhance reservoir characterization. By systematically calibrating porosity, permeability, irreducible water content, and pore throat size, the approach improves the reliability of NMR-derived petrophysical models.



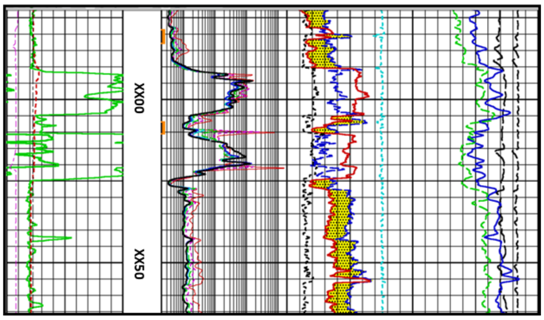
Maciej Kozlowski *works for Halliburton as a petrophysicist. He completed an MS degree in exploration geoscience at the AGH University of Science and Technology in Kraków, Poland. He has worked for exploration and production operators, service providers, and consulting groups. His technical interests include open-hole formation evaluation integration, spectral neutron-gamma interpretation, NMR, rock physics modeling, acoustic interpretation, as well as cased-hole logging interpretation and integration.*

Operations Petrophysics and Log Quality Control (LQC)

An introduction to Wireline Logging Operations for Students and Recent Graduates

Adrian Leech; GAIA Earth Group

Many students and recent graduates will be attending this seminar with little or no knowledge as to what terms such as petrophysics, wireline logging, log data and a dozen other words or phrases refer to. Indeed, they may not know why and how petrophysical data is obtained.



This talk hopes to address this with a basic introduction to the subject forming a background to the topics that will be covered during the course of the day.

Should recent graduates choose to include Petrophysics as part of their broad training programme then they may well be involved in the planning and supervision of wireline operations under the banner of **Operations Petrophysics** which forms an excellent pathway into an interest in the subject and hence a career as a Petrophysicist.

Agenda:

- An introduction to wireline logging
- Basic measurement theory
- Operations Petrophysics - Preparing for a logging operation
- Operations Petrophysics - Real-time LQC

***Adrian Leech** has been in the Oil and Gas Industry for over 45 years starting out as a Schlumberger wireline logging engineer in South America. He became a Wireline QAQC Consultant in 1998 and since 2003 has helped build The Gaia Earth Group into a leading Wireline and LWD QAQC and Wireline Conveyance Consultancy worldwide.*