New Technology Seminar

LPS

Thurs 10th January 2019

The Geological Society, Burlington House, London

	Start time	End time	Presenter	Affiliation	Title
	09:00	09:20	**Registration**		
	09:20	09:30	Dawn Houliston	LPS President	Welcome address
1	09:30	10:00	Paul Glover	Leeds University	Nanoparticles and Carbon Quantum Dots in Reservoir Characterisation and Enhanced Hydrocarbon Production
2	10:00	10:30	David Psaila	AnalyticSignal/ Schlumberger	Accelerating and Enhancing Petrophysical Analysis with Machine Learning
3	10:30	11:00	Matt Bowyer	PDS Group	Testing the impact of saturation-height functions on reservoir models - AVA software
	11:00	11:30	**Break**		
4	11:30	12:00	Adam Moss	AKM Geoconsulting Ltd	Fine Resolution Core Mineralogy from Infrared Spectroscopy and How to Use these Data to Calibrate Logs.
5	12:00	12:30	Filippo Casali	Geolog International Ltd	Geochemical Signals in Siliciclastic Bodies: Halfway Between Chemistry and Petrophysics
6	12:30	13:00	Davide Di Tommaso	Weatherford	LWD High Resolution Ultrasonic Imager Deliver Innovative, Cost-Effective Solutions
	13:00	14:00	**Lunch - kindly sponsored by Halliburton**		
7	14:00	14:30	Rodney Howard	Halliburton	Diagnosing Well Integrity, An Industry Challenge
8	14:30	15:00	Duncan Troup	Archer Wireline	VIVID (cement performance)
9	15:00	15:30	Peter Hill	Baker Hughes GE	Technology advances in cement evaluation and reservoir monitoring
	15:30	16:00	**Break**		
10	16:00	16:30	Duncan Troup	Archer Wireline	ComTrac (carbon composite rod intervention system)
11	16:30	17:00	Martin Leonard	PetroMac	Positive tool orientation significantly improves data quality and enables gravity descents of wireline tool-strings to extreme deviations
	17:00	17:10	Dawn Houliston	LPS President	Closing remarks
	17:10	Onwards	**Wine & snacks - kindly sponsored by PDS Group**		

Seminar is FREE to all and no need to register

Includes lunch (kindly sponsored by Halliburton)
and post-seminar wine and snacks (kindly sponsored by PDS Group)

Doors open at 9am.
For more information for this event please visit ***www.lps.org.uk/events/***

Nanoparticles and Carbon Quantum Dots in Reservoir Characterisation and Enhanced Hydrocarbon Production

Paul Glover, University of Leeds

The hydrocarbon industry is currently transitioning from a world where hydrocarbon reservoirs were large and homogeneous to one where newly discovered reservoirs are often small, heterogeneous and anisotropic, and therefore expensive. In this scenario it becomes of prime concern to (i) extract as much hydrocarbon from existing reservoirs as possible, and (ii) to characterise the new heterogeneous and anisotropic reservoirs as well as possible. The use of carbon quantum dots and nanoparticles represent two new approaches to solving each of these difficulties.

Enhanced oil recovery: Nanoparticles can be used to enhance oil recovery (EOR) by employing their ability to modify the wetting characteristics of the reservoir and to open up flow pathways where hydrocarbon is trapped. Following a systematic study of the effect of TiO2 during nanoparticle-assisted brine flooding, we show that the presence of nanoparticles can significantly improve hydrocarbon production. Rutile TiO2 nanoparticles have been synthesized, stabilized using surfactant, and used in water-flooding of water-wet Berea sandstone cores in order to quantify the improvement in hydrocarbon production as a function of stabilizer concentration, water salinity, nanoparticle size and nanoparticle concentration. Enhancement in oil recovery as a function of nanoparticle concentration has been evaluated both at the water breakthrough point and at the end of flooding. The results show that the presence of nanoparticles enhances recovery irrespective of their concentration, but its effect is variable. The measured recovery factor for water-flooding in the absence of nano-particles was 30.3% of OOIP, increasing marginally with the addition of surfactant (30.8% OOIP). Addition of six different nanoparticle concentrations, varying between 5 ppm and 500 ppm, improved the recovery factor in all cases. A concentration of 20 ppm showed the greatest improvement of recovery factor at breakthrough (39.8% OOIP), which represents 30.5% improvement on standard water-flooding. However, all nanoparticle concentrations between 10 ppm and 500 ppm showed approximately the same improvement of oil recovery by the end of the nanoparticle-flood, at about 41.8% OOIP (37% improvement on standard water-flooding). The two different behaviours at may be due to the operation of two different processes, one which modifies the wettability of the rock and a second which causes so-called “log-jamming” of particles in preferential water channels allowing oil in previously non-preferential flow channels to be produced towards the end of the flood process. In any case, the improvements in recovery factor are scientifically and commercially significant.

Reservoir characterisation: Current reservoir characterization methodologies all have limitations on detection range and resolution, making them ineffective in heterogeneous and isotropic reservoirs. We propose a pioneering way to use carbon quantum dots (CQDs) as nanoparticle supertracers, which not only are able to be transported through a reservoir functioning as a conventional tracer, but also act as nanoscale sensors to obtain useful information inside the reservoir, providing much more information than tracers could ever supply. Carbon Quantum dots have a number of very important advantages over other reservoir interventions: they are easy and cheap to produce from natural and sustainable stock resources. They have almost no environmental impact, being nontoxic and biocompatible and they biodegrade naturally. Their small-scale quantum behaviour exhibits itself as well-controlled fluorescence, allowing CQD concentration to be easily and accurately measured. We have prepared CQDs from Xylose and shown them to possess excellent stability in high ionic strength solutions, together with durable absorbance and fluorescence characteristics. Our core-flooding results reveal that CQDs can be transported easily through packed columns and

reservoir core samples, showing tracer-like migration capability regardless of particle concentration and ionic strength, as detected by both UV-Vis (On-line) and CLSM (off-line) measurements. We have also demonstrated that oil saturation can be measured remotely by using CQDs based on its breakthrough properties. In CQDs we have a modern and flexible tracer for heterogeneous and anisotropic reservoirs that have the potential for being geo-engineered as nanoscale sensors.

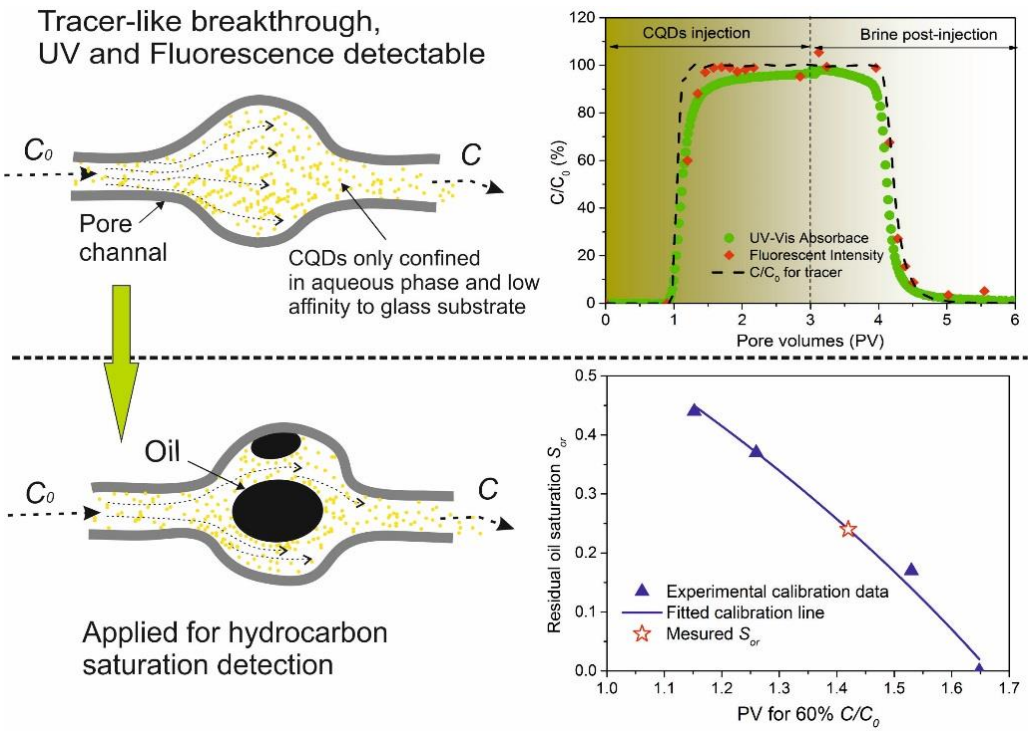

Figure 1. UV tracer behaviour of CQDs allows the presence of hydrocarbons trapped in pores to be recognised, and water saturation to be calculated.

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Accelerating and Enhancing Petrophysical Analysis with Machine Learning

David Psaila – Schlumberger

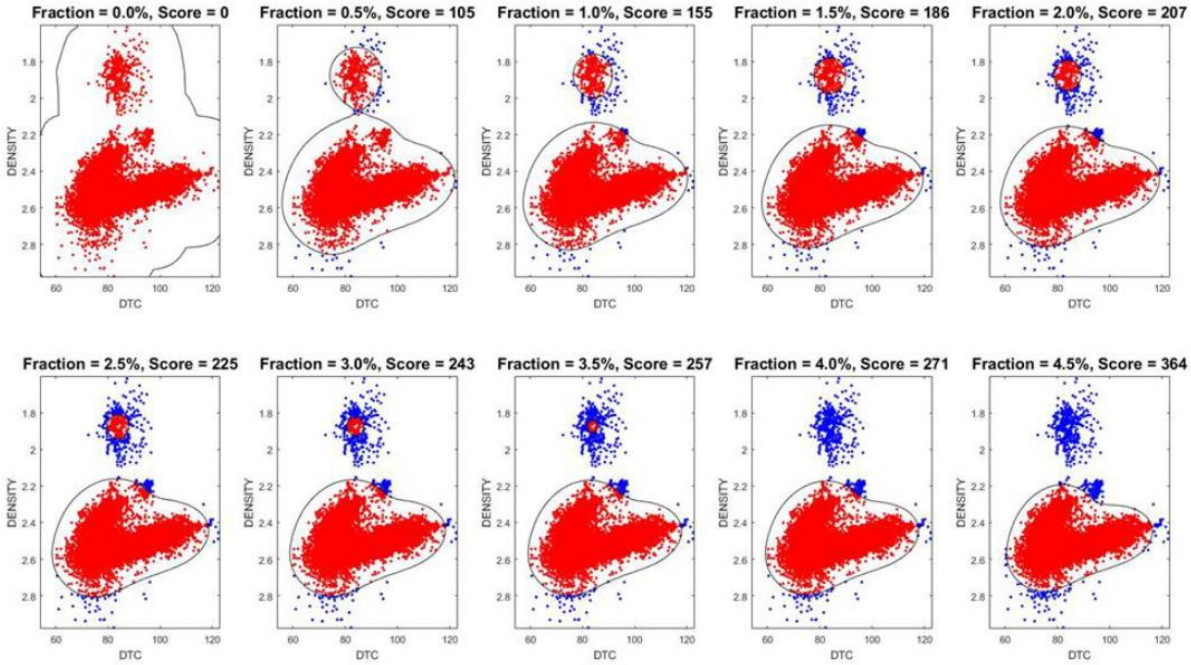
Recent advances in data science and machine learning (ML) have brought the benefits of these technologies closer to the main stream of Petrophysics. ML systems, where decisions and self-checks are made by carefully designed algorithms, in addition to executing typical tasks such as classification and regression, offer efficient and liberating solutions to the modern Petrophysicist. The outline of such a system and its application in the form of a multi-level workflow to a 59-well multi-field study are presented in this paper.

The main objective of the workflow is to identify outliers in bulk-density and compressional slowness logs, and to reconstruct them using data-driven predictive models. A secondary objective of the project is to predict shear slowness in zones where such data do not exist.

The system is fully automated, designed to optimize the use of all available data, and provide uncertainty estimates. It integrates modern concepts for novelty detection, predictive classification and regression, as well as multi-dimensional scaling based on inter-well similarity.

Benchmarking of ML results against those created by human petrophysical experts show the ML workflow can provide high quality answers that compare favourably to those produced by petrophysical experts. A second validation exercise, that compares acoustic impedance logs computed from ML answers to actual seismic data, provides further evidence for the accuracy of the ML generated results.

The ML system supports the Petrophysicist by easing the burden on repetitive and burdensome quality control tasks. The efficiency gains and time savings created can be used for enhanced effective cross-discipline integration, collaboration and further innovation



Testing the impact of saturation-height functions on reservoir models

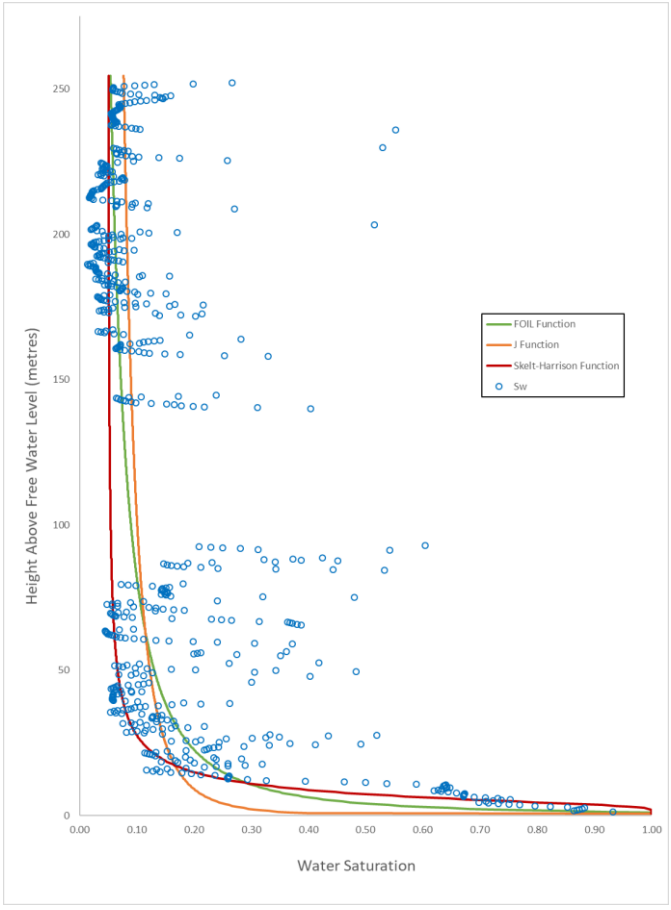
Matthew Bowyer - Petrotechnical Data Systems Group Ltd.

Saturation-height functions are of great importance for the determination of in place hydrocarbon volumes in reservoir models. Saturation-height functions can also provide insight into variations in free water level within a field, and also in the identification of swept zones.

This presentation introduces several of the well-known methods for deriving saturation-height functions, including Leverett-J, Skelt-Harrison and Cuddy FOIL. The presentation also shows other general methods for calculating and modelling saturations in reservoir models, and highlights the differences between the classical methods and the more general approaches.

The saturation-height methods are demonstrated using well data from two fields; both wells have suites of electric logs, with both routine and special core analysis data available in one of the wells.

The various saturation-height methods are QC'd visually against the log derived saturations, but also and importantly, in terms of modelled in place hydrocarbon volume, with structural relief playing an important role. The effect each saturation-height method has on the representation of the transition zone is also displayed.



Fine Resolution Core Mineralogy from Infrared Spectroscopy and How to Use these Data to Calibrate Logs

Dr Adam K Moss – AKM Geoconsulting Ltd & Dr Gavin Hunt – Spectra-Map Ltd

Over the last decade, hyperspectral infrared spectroscopy has become recognised as a useful technique for quantifying mineral content in core, plugs and cuttings. Mineral abundance can be defined on a sub-millimetre level. These fine scale data are extremely valuable for both geologists and core analysts. This talk aims to show methodologies to use these high-resolution mineral data to help calibrate common log interpretation models.

Log interpretation models all include constant parameters that relate to some property of the rock being tested. For example, to obtain shale volumes from gamma logs requires an estimate of the gamma response in both 'clean' sand and high shale content rocks. The log interpreter will make an educated guess as to the value of these parameters based on all available information. Knowledge of the rocks mineralogy greatly enhances the selection of these parameters. Awareness of minerals spatial distribution allows the log interpreter to vary/zone these parameters throughout the logged section.

Examples from reservoir sections will be shown to illustrate methods to calibrate different log interpretation models including, shale volume from gamma logs, density log porosity models and clay bound water from NMR.

Geochemical Signals in Siliciclastic Bodies: Halfway Between Chemistry and Petrophysics

F. Casali, A. Pozzi – Geolog International B.V.

Today, increased Surface Logging datasets, including different types of advanced analyses on both cuttings and mud gas, are having a deep impact on Integrated Reservoir Characterization and its related uncertainties.

Considering the high level of uncertainties which affect the primary goals of a hydrocarbon reservoir study, direct access to valid and robust additional data from drilling parameters and rock properties can significantly contribute to the understanding of stratigraphy and model geometry definitions. The additional possibility to have lab quality geochemical data obtained while drilling at the well sites, also facilitates making better decisions in real time.

Two case studies will be presented, where application of basic and Advanced Surface Logging (ASL) Technology, led to multiple benefits in reservoir structure definition and production optimization. The correct interpretation of inorganic geochemistry, when correlated with drilling parameters and mud gas content finds fruitful application in both conventional and unconventional plays.

The first study refers to a tight reservoir, where the identification of main potential sweet spots, correlated with and supported by mud gas data, can optimize the production capability of the well. Advanced X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) drill cutting characterization adds significant value in drilling optimization, reservoir zonation and completion design.

The second case study, conducted in a conventional reservoir where the hydrocarbon accumulation was in a heterogeneous sandstone, demonstrates how the chemical and mineralogical variations within rock sequences enable a reservoir zonation to be created, actively contributing to improved well completion strategies. The natural radioactivity of the investigated clastic sedimentary rock, precluded the application of Gamma Ray, as conventional interpretation of the tool's response was unreliable. The capabilities of wellsite inorganic and organic geochemistry (ASL Technology) permitted the identification of two separate reservoirs with differing properties.

ASL Technology, combined with Chemostratigraphy is demonstrated to provide rapid formation evaluation during drilling. Additionally, when correlated to 'hard data', it can be actively included in the database creation for the Reservoir Integrated Petrophysical characterization.

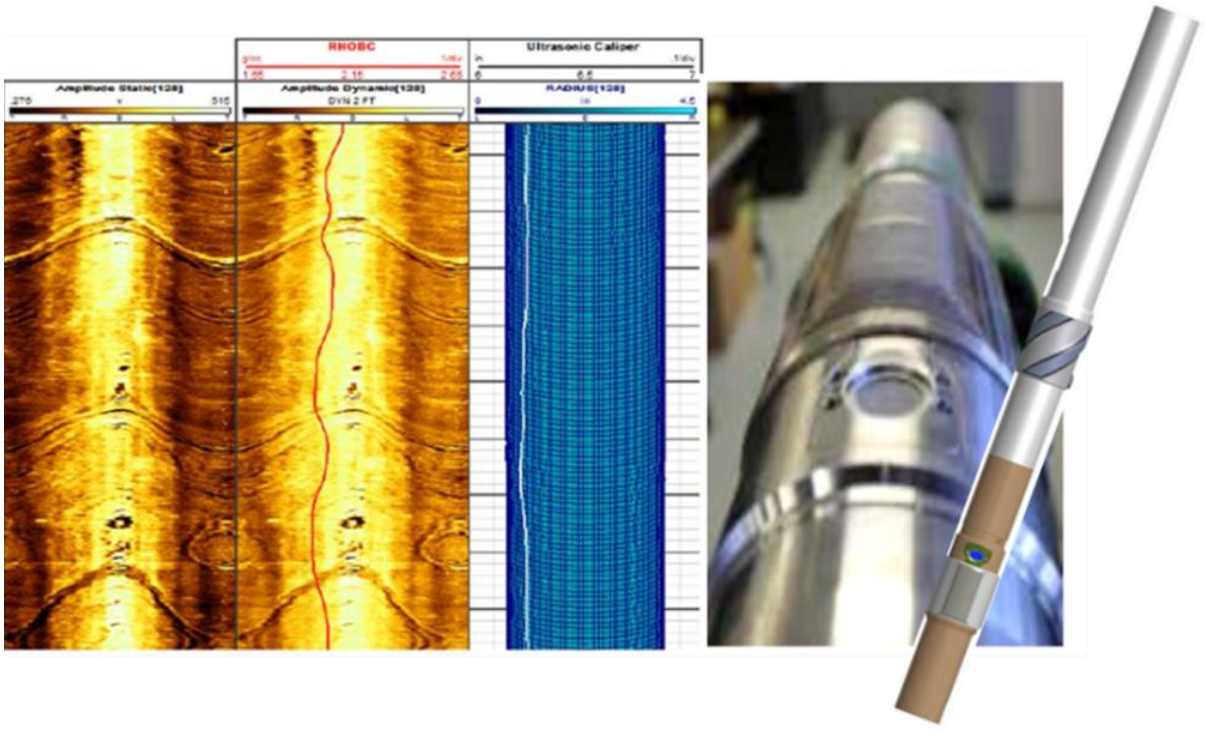
LWD High Resolution Ultrasonic Imager Deliver Innovative, Cost-Effective Solutions.

Davide Di Tommaso, Weatherford

This presentation discusses an innovative application based on borehole images from a new LWD ultrasonic tool to obtain macro porosity.

A new tool was developed by adapting a high-frequency piezo-electric transducer to an LWD drill collar to serve as both transmitter and receiver. This transducer transmits an ultrasonic pulse and measures both the amplitude and two-way travel time of the acoustic reflection from the borehole wall. The LWD tool scans the borehole while rotating to obtain high-resolution caliper and high-resolution amplitude images in both oil-based and water-based muds. The ultrasonic imager can reveal open and cemented natural fractures, drilling-induced fractures, borehole breakout, fine-scale bedding, and other geological features such as vugs and stylolites.

High-resolution amplitude images from this new tool disclose its full potential and advantages, especially in carbonate reservoirs drilled with oil-based mud: high-amplitude signals responds to the matrix porosity as low- amplitude signals does to low acoustic impedance material, such as clay or pyrite, but also fluid-filled vugs. Thus, applying a cut off to discriminate high from low amplitude, it is possible to calculate the contribution of the vugs to the porosity that can be used as an input to improve petrophysical formation evaluation.



Diagnosing Well Integrity, An Industry Challenge

Rodney Howard, Halliburton

VIVID (Cement Performance)

Duncan Troup, Archer Wireline

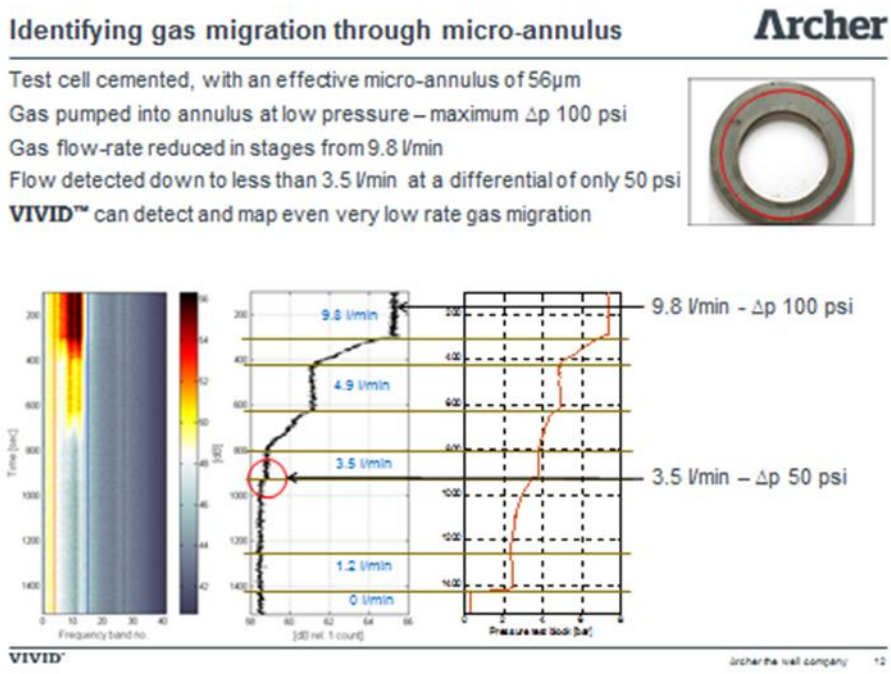
Performance versus condition; new broadband acoustic technology reveals the performance of cement barriers

Traditional methods of cement analysis rely on evaluating the placement and condition of cement, and estimating the linear extent of cement behind the casing required to ensure hydraulic isolation. However, there are innumerable examples of cemented annuli exhibiting sustained pressure at surface despite a good cement condition log. In such cases there will be movement of fluid within the annulus which, even if small, will generate acoustic energy that can be used to indicate a failure of the performance of the cement.

A number of test cells consisting of tubing cemented inside casing were used under controlled conditions to evaluate the detection threshold of a new broadband acoustic sensor platform. The cells covered cases including free-pipe, a small channel, exterior micro-annulus, and “good” cement, and evaluated sealing performance against both water and gas. Reliable detection of flow rates as low as 0.02 litres per minute was consistently recorded.

This new approach of cement performance evaluation has been validated on no fewer than 8 wells in a field planned for permanent abandonment. Logging through tubing, the charging source and the gas migration path of all 8 wells was successfully logged providing full planning information prior to mobilisation of a rig.

https://archerwell.com/products-services/wireline/cased-hole-logging-services/vivid/



Technology advances in cement evaluation and reservoir monitoring

Peter Hill, Baker Hughes GE

Oil and Gas Operating Companies work in a market constrained by, at best, revenue uncertainty and, currently, low product prices.

They are under financial constraints to maximise cash flow and return on capital like rarely before.

FID approvals for new, multi-decade developments remain hard to justify.

These assets also must be decommissioned at the absolute minimum cost consistent with industry and regulatory standards.

This situation requires existing assets' life cycles (reservoirs as well as well infrastructure) to be optimised and every Dollar of both CAPEX and OPEX spent wisely through data-driven decisions and planning.

This paper will describe Baker Hughes GE Wireline Services' perception of our clients' situation and our technology responses to these constraints; particularly for

Reservoir-performance surveillance

Flow optimisation of fluids from reservoir to wellhead

Ensuring continued mechanical and chemical integrity well assets

P&A operational and cost efficiency

ComTrac (carbon composite rod intervention system)

Duncan Troup, Archer Wireline

Field deployments prove the versatility of the ComTrac® carbon composite rod system

Since its conception as a radically new and flexible intervention system leveraging the strengths of advanced carbon composite technology, the ComTrac® system has been continuously developed into a field proven package. The all-electric unit and drive system bring unprecedented control for precision logging while retaining power required for heavy intervention programs, but the core advantage for the system stems from the unique properties of the rod. Field experience has demonstrated not only the strength, lightness and low friction of the rod, but also provided encouraging data on the fatigue and wear properties of the rod.

The first three field deployments of the ComTrac® system have addressed three key areas where the properties of carbon composite materials bring significant advantages. Following the first trial consisting of intervention work involving long heavy toolstrings as well as precision logging, the system then utilised the rod's rigidity to access a short lateral section without the need to mobilise a tractor service. The third deployment was a complex intervention involving fishing, followed by high resolution logging and culminating in 2 perforation runs – all on tractor. Planning is now ongoing for even more challenging wells where ComTrac® is the only economic option.

https://archerwell.com/products-services/wireline/conveyance-and-mechanical-slickline-services/comtrac/

https://archerwell.com/archer-completes-record-breaking-horizontal-perforation-job-with-comtrac-carbon-composite-rod/

Positive tool orientation significantly improves data quality and enables gravity descents of wireline tool-strings to extreme deviations

Martin Leonard, PetroMac

This presentation details the benefits of positive orientation of the wireline tool-string and its sensors in the borehole.

Correct orientation of the tool-string via ultra-low friction wheels, instead of traditional positioning accessories, allows gravity descents to extreme deviations that have previously only been performed by Drill Pipe conveyance (TLC), LWD or Tractor. In addition, tool sensors that take directional measurements are kept in constant contact with the borehole wall, ensuring quality data when running both into and out of the borehole.