Real Time Formation Eva

A team from Aberdeen University have developed a method of generating simulated wireline logs with the potential to produce real-time wellsite data, reducing costs and supplementing conventional data.

Jane Whaley

"There are a number of things we want to find out from borehole data," Andrew Hurst, Professor of Geology at Aberdeen University in Scotland, points out. "We need to know saturation - whether the sediments contain oil, gas or water - and the nature and storage capacity of the rocks we are drilling into, as shown by porosity. But what do we actually do in reality? We measure what we *can* measure, rather than what we ultimately want. So we determine things such as the natural radioactivity, giving us the gamma log, and we measure electron density, which is similar to the bulk density of formations, leading eventually to an estimate of porosity."

"Basically, we derive measurements of things we don't want to know, and turn them into things we do want to know. This is the science of formation evaluation," Andrew says."

"With colleagues, I started wondering if there were other, more direct factors we could use to measure saturation and porosity," he continues. "For example, a number of parameters are recorded continuously through mud logging at the well site, including drilling parameters like rate of penetration, torque and weight on bit, all of which directly tell us something about the physical properties of the rock through which the drill bit is passing. Hydrocarbon gas released by drilling circulates very rapidly up the borehole, and interpretation of gases such as He, Rn, CO_2 and C_1 to C_4 can help predict the type and fluid content of the rock that is being drilled at any given time.

'Fuzzy logic'!

Petrophysicist Steve Cuddy was carrying out independent research at Aberdeen University and introduced Andrew to some soft computing techniques like 'genetic algorithms' and 'fuzzy logic'.

"These allow you to help predict the unknown based on existing knowledge," Andrew explains. "Steve was already successfully applying them to predict log responses where wireline log data were distorted or absent, using trends recorded from adjacent, geologically similar borehole intervals (the log repair process). We thought that maybe we could use these 'soft' computing techniques to combine all the available well-site information such as gas measurements and drilling parameters to make predictions similar to wireline logs."

With financial help from the Scottish Enterprise 'Proof of Concept Scheme', Andrew and Steve hired a computational mathematician to work alongside themselves and a dedicated geologist at Aberdeen University. Together, an advanced computational method (Gaslog) was developed that makes proxy logs for most wireline/LWD logs, which can faciltate the direct prediction of porosity and saturation without carrying out conventional formation evaluation. This advanced computational method is known as 'Gaslog'.

Photo: Jane Whaley

Professor Andrew Hurst has enjoyed a career in both academe and the oil industry. He worked for a number of years for Statoil, and then Unocal, before following a very distinguished academic career, and is currently Chair of Production Geoscience at the University of Aberdeen. He was Founding Editor of Petroleum Geoscience and a Council Member and Trustee of the Geological Society of London whilst also serving on the committees for many of the major professional organisations, including AAPG, EAGE and PETEX. Professor Hurst was the recipient of the prestigious EAGE Wegener Medal (2004) and the AAPG Distinguished Service Medal (2007).

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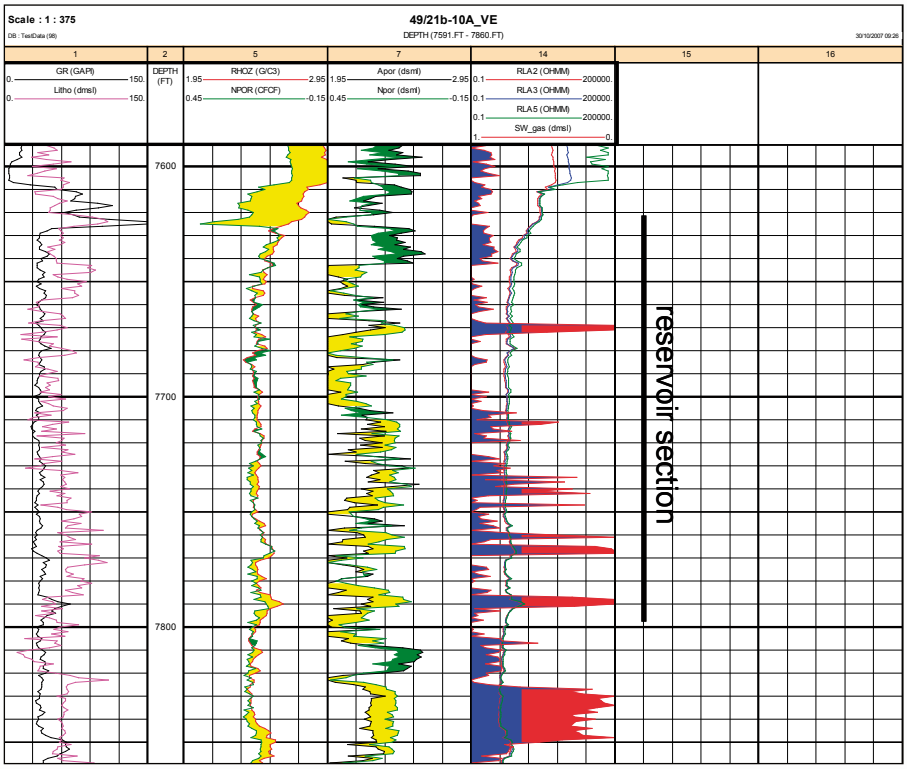
'Gaslog' generates real time curves

"Within minutes of drilling parameter data being received at the wellsite, Gaslog generates large numbers of curves, offering a range of well simulations, something that is not available in any other way," explains Andrew. "Modern wellsite collection techniques mean that this analysis can be performed in real time, 24 hours a day, 7 days a week, all controlled from a single site here in Aberdeen, with little or no additional data acquisition costs. This offers significant savings in both time and money through early assessment of formation quality and saturation."

Gaslog produces, for example, the Litho log, which mimics the main role of the gamma log, lithology prediction. Litho is particularly good at recognising lithological boundaries, identifying shale horizons missed by more conventional logs and distinguishing lithological changes at higher resolution than gamma-ray logs. It is anticipated that when the product is fully developed a broad range of wireline log proxies, pore pressure predictions and estimations of rock mechanic properties will be possible.



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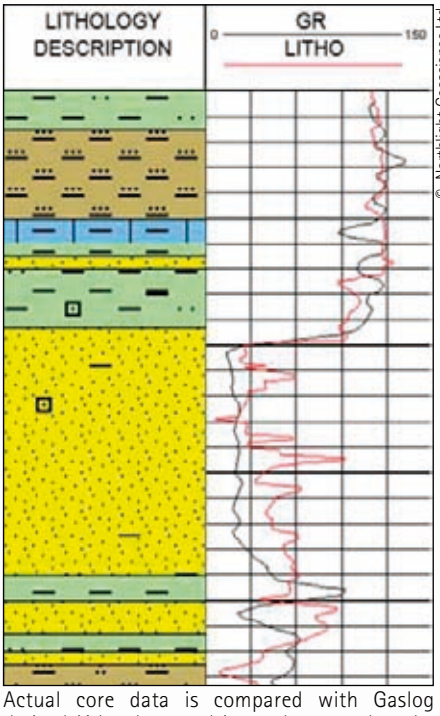
An example of Gaslog curves from a low-permeability gas reservoir is compared to conventional wireline log data. In Track 1 Litho is a proxy for gamma-ray (GR) logs and resolves finer-scale variations in lithology than GR. In Track 2 the density-neutron wireline crossplot compares with Gaslog proxies Apor and Npor (Track 3). In Track 4 the wireline resistivity logs are compared with Gaslog predictions of saturation (blue = formation water, red = gas).



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Actual core data is compared with Gaslog derived Litho data, and it can be seen that the Litho curve shows greater variation and higher resolution within the reservoir compared to the wireline derived GR curve. The Litho curve also shows good correspondence with the core data, which was not made available to the Gaslog team for study prior to the analysis.

"We can offer real assistance to both drilling operations and petrophysical evaluation," Andrew continues. "In addition to real time prediction of saturation and porosity, the tool can be used to aid drilling through geosteering and by locating suitable well test sites, as well as giving quality assurance. Being able to predict rock strength ahead of bit with this technique is an added operational advantage for drillers."

"Gaslog has also been successfully used to analyse historical data," Andrew adds. "In the North Sea, for example, where diligent explorers are always looking for new opportunities, we can go back to old wells and create logs or repair damaged or incomplete records, highlighting aspects of geology that may have been overlooked. We can also provide more information on fractured reservoirs, especially where shale boundary layers may have been missed due to mud contamination."

Northlight Geosciences

During 2006, Gaslog was independently assessed as having good commercial potential and a 'spin-off' company from the University was formed. This is known as Northlight Geosciences and began trading in July 2007. The company has two full-time employees, with Andrew and a part-time CEO completing the team.

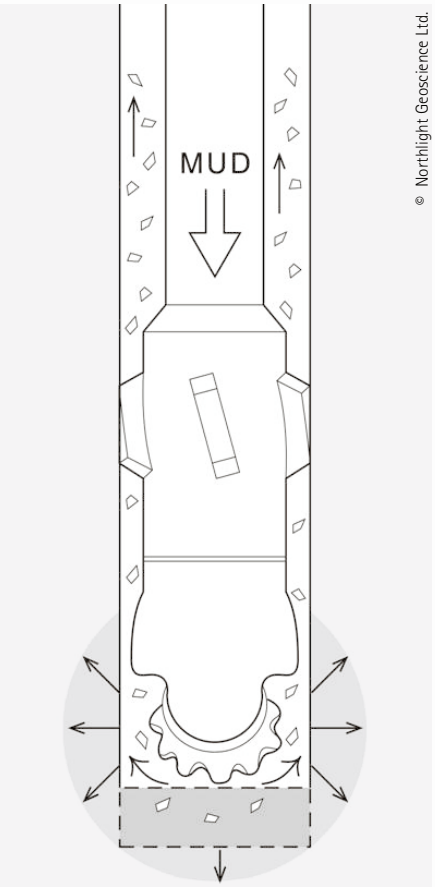
"We are now finalising the product in collaboration with clients, because you never really know the finer points of what is needed with products until you work with clients. Our clients include both large E&P companies who heard what we were doing and had an application in mind, and smaller clients with specific problems that this tool can assist or solve. At the moment we are working, or have worked, in the North Sea, in Yemen, and offshore Vietnam and are looking at a host of other places, but the team will currently stay here in Aberdeen. The venture is going well at the moment – in fact if only two-thirds of the projects under discussion materialise, we will in six months exceed the turnover we had anticipated for 12 months."

At the moment Andrew is very busy steering the technology and interpretation

side of Gaslog, as well as marketing the product, in addition, of course to his duties at the University of Aberdeen.

"I'm really enjoying this. I love to see ideas come to fruition," Andrew explains. "I really get a kick out of doing something that other people find useful. That's the biggest buzz I can get."

Mud is used to lubricate, provide weight and to circulate the cuttings from the well bore. The circulating mud contains native fluids and variations in hydrocarbon gas compositions and volumes which can be measured and analysed at the well site and a continuous record of drilling parameters is kept. Data in digital format is then fed into GASLOG and prediction of rock and fluid characteristics can be made, which are reproduced in a conventional borehole logging format for interpretation.



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Formation evaluation methods

Formation logging is currently carried out either by wireline logging or Logging While Drilling (LWD). Wireline collection tools are lowered into a drilled borehole on a cable, and this method has the advantage of being consistent in data acquisition but can only be undertaken when drilling has stopped and the drill bit recovered, giving time and cost implications. Typically, an offshore operation takes 1 to 2 days, with operational, logistic, personnel and rig costs exceeding $1m.

LWD tools, by contrast, are integrated into the bottom-hole assembly and measure properties of a formation before drilling fluids invade too deeply. The technique is risky in a hostile operational environment and also expensive, but can collect valuable data where conventional wireline tools are not appropriate, such as in highly deviated wells. Both wireline and LWD techniques have difficulty in collecting data in HT/HP wells due to the temperature limitations of the electronics.

Measurements made through traditional logging include electrical properties such as resistivity and conductivity at various frequencies, sonic properties, active and passive nuclear measurements, dimensional measurements of the wellbore, formation fluid sampling, formation pressure measurement and wireline-conveyed sidewall coring tools, amongst others.

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