SOCIETY OF PETROPHYSICISTS AND WELL LOG ANALYSTS
SAUDI ARABIA CHAPTER

10th SPWLA Saudi Arabia Chapter Online Topical Workshop
October/November 2021

SPWLA Saudi Arabia Chapter (SAC)

DATA DRIVEN PETROPHYSICS – Challenges and Best Practices

Digital Transformation, what is it? Machine Learning (ML) and Artificial Intelligence (AI), how do they work and impact us, the petrophysicists? Those topics are what everyone keeps talking about nowadays, in our industry and around the globe. But do we really know what they mean? And how they will be used and impact the future of upstream business in general and petrophysics in particular? This online workshop is developed to answer some, surely nor all, of these questions. It will open with a session introducing the fundamentals of data analytics and ML/AI where experts in the field will share their knowledge and experiences. The following sessions will explore the applications of data driven petrophysics in the subject matters of formation evaluation, geosteering, dynamic reservoir surveillance, laboratory core and fluid analyses, and unconventional resources evaluations. Since we are merely at the very beginning of this digital transformation, a session dedicated to emerging technologies in data driven petrophysics will conclude this topical workshop.

Opening & Keynote Speeches by:

Mr. Khalid Zainalabedin
Manager - Reservoir Description and Simulation Department
Saudi Aramco

Dr. Dhafer Al-Shehri
Chairman of Petroleum Engineering Department
KFUPM

Mr. Ziad Jeha
KSA and Bahrain Managing Director
Schlumberger

Dr. Ridvan Akkurt
AI &Analytics Petrophysics Advisor
Schlumberger

	Date	Time	Subject
1	29-Sep-21	12:00-15:00	**Fundamentals of data analytics and machine learning**
2	06-Oct-21	12:00-15:00	**Data driven petrophysics- Data Preparation and Quality Control**
3	13-Oct-21	12:00-15:00	**Data driven petrophysics- Applications in borehole imaging and geo-steering**
4	20-Oct-21	12:00-15:00	**Data driven petrophysics- Applications in Rock Typing and Formation Evaluation**
5	27-Oct-21	12:00-15:00	**Data driven petrophysics- Applications in Reservoir Evaluation**
6	03-Nov-21	12:00-15:00	**Data driven petrophysics- Applications in Formation Testing and Sampling**
7	10-Nov-21	12:00-15:00	**Data Driven Petrophysics- Applications in Unconventional Source Rock Evaluation**

Workshop Target Audience:

- Petrophysicists as well as logging and log analysists
- Reservoir engineers and simulation engineers
- Geophysicists, Geologists, and Geo-Modellers
- Rock/geo-mechanical Subject Matter Experts
- Drilling and Production engineers
- Upstream Researchers

This event is sponsored by: Schlumberger

Registration

www.spwla-saudi.org

info@spwla-saudi.org

Maximum attendees 250 in each session

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SPWLA (SAC) Data Driven Petrophysics Workshop Program

Session 6 Agenda

Session 6 Technical Session - Applications in Formation Testing and Sampling

Ahmed Abouzaid (Baker Hughes) / Sherif Ghadiry (Schlumberger)

Wednesday, 3 November 2021

12:00-12:10	**Session opening (all times are KSA times GMT+3)**		
12:10-12:45	Artificial Intelligent Assisted Formation Pressure Testing Job Planning and Optimization	Bin Dai	Halliburton
12:45-13:20	Delivering First Insight into Reservoir Fluid with the Power of Digital Innovation	Shahnawaz Molla and Maneesh Pisha-	Schlumberger
13:20-13:55	Automated fluid characterizing Technique Based on ML and Fluid Phase Diagram in Real time	Anup Hunnur	Baker Hughes
13:55-14:30	Automated Workflow to Indicate Reservoir Connectivity Through Asphaltene Equilibrium	Melanie Jensen	Schlumberger
14:30-14:45	**Session 5 Summary and closing remarks**	**Mark Ma**	**Saudi Aramco**

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Artificial Intelligent Assisted Formation Pressure Testing Job Planning and Optimization ,

Bin Dai, Radompon Sungkorn, Farrukh Hamza, Jimmy Price, Christopher Jones, Tony van Zuilekom, Halliburton

Abstract

Formation pressure testing provides important information for exploration and production activities. Accurate reservoir pressure measurements are necessary to help ensure that a well is drilled safely and to identify and evaluate the potential and value of the discovery. The interpretation of pressure gradients provides the reservoir compartmentalization structure of a well, oil-gas-water fluid contacts, and can indicate compositional grading, as evidenced by second order density changes. However, this assumes that the pressure testing quality is sufficient for high resolution analysis. Unfortunately, obtaining quality data from formation testing can be difficult and prolonged. Locations initially selected for formation pretesting along the wellbore are often not optimal, and the time spent conducting pressure testing on those locations is wasted. In addition, pressure testing of the suboptimal locations typically requires twice as much time as for high quality locations. Therefore, considerable operational time savings can be realized if low quality locations can be avoided.

A multivariate machine learning method is presented that builds a statistical correlation between the formation pressure test quality index and conventional wireline logging data. A large set of formation test and openhole logs data, which includes 250 wells and more than 8000 pressure test stations, were used to build global machine learning models. Different models were built based on different openhole logs data combinations, allowing the algorithm to be used for different logging tool combinations. The validated models can predict the pretest quality index for locations along the wellbore with the same spatial resolution as input logs. The predicted quality index can be used to guide the user to select optimal locations for conducting pretest. In addition, the predict quality index can be used to design optimal job plan to allow multiple pretest probes to be set at optimal locations simultaneously, therefore reduce the time spending on tool movement and eliminate depth uncertainty for those stations.

Biography

Bin Dai joined Halliburton in 2013. He currently serves as a senior scientific advisor in the Halliburton's sensor physics department, leading the data science and modeling group responsible for downhole fluid identification sensor design, formation pressure test and sampling modeling, and automation of wireline formation testers using artificial intelligence and machine learning techniques. Dai received a PhD degree in analytical chemistry, with a specialization in chemometrics and NIR spectroscopy, from the University of Kentucky, and an M.B.A from Washington University in St. Louis, Missouri. He has 20 issued patents, more than 40 patent applications, and more than 40 papers and/or presentations.

Delivering First Insight into Reservoir Fluid with the Power of Digital Innovation

Shahnawaz Molla and Maneesh Pisharat, Schlumberger

Abstract

Availability of reliable information about the hydrocarbons is key to reservoir evaluation. We have developed a digital workflow to estimate reservoir fluid properties such as the fluid type, gas-oil-ratio (GOR) and fluid composition using mud-gas data while drilling, which offers the earliest indication of the hydrocarbon content and type in the formation. We used the real-time data from advanced mud-gas analysis to build a reservoir fluid model powered by machine-learning (ML) algorithms. This direct measurement involves detection of the hydrocarbons liberated from the drilled rock into the drilling fluid. Our digital solution – Fluid Prediction Workflow– transforms the basic mud-gas data to actionable insights into the reservoir fluids in real-time. This workflow delivers the earliest information about the fluid composition and variability in the reservoir—therefore provides key elements for planning formation evaluation jobs.

Advanced mud-gas analysis provides laboratory quality data of the lighter hydrocarbon fraction (C1 to C5) of reservoir fluids during drilling. However, to build a complete picture of the reservoir fluid, we need the composition of the heavier fraction (C6+ fraction). To bridge this information gap, we created a ML workflow that generates probabilistic estimations of reservoir fluid type, C6+ fraction and GOR from mud-gas. Our current workflow uses a set of preconstructed ML models to generate estimates of the fluid properties. The models were trained using a fluid database that was compiled from fluid measurements in reservoir laboratories. With the help of domain experts, we screened data to ensure that the training data was reliable and representative of reservoir fluids from different geographic locations. Using exploratory data analysis, we identified many features in mud-gas composition which were used to build a random forest classification model for fluid type identification. We used regression to predict C6+ fraction from the mud-gas data and subsequently the GOR of the reservoir fluids. The models were selected and trained to optimize the performance of the fluid prediction workflow in real-time application. This workflow was tested on multiple mud-gas data sets and validated with laboratory analysis.

This method has huge implications in real time decision making and operational efficiency. Insight into the fluid properties while drilling will improve formation evaluation and influence operational decisions. Examples from a field with complex fluid distribution showed that predicted fluid properties can be used to determine fluid gradient and reservoir compartments.

Biography

Shahnawaz Molla is a Senior Research Scientist at Schlumberger Doll Research. He has over 10 years of experience in reservoir fluid characterization and analysis in Schlumberger. He has developed several patented microfluid technologies for PVT measurements of reservoir fluids in fluid analysis. Recently, he has developed digital solutions powered by machine learning and artificial intelligence to generate early insight into reservoir fluids during exploration. He has published extensively in peer reviewed journals.

Maneesh Pisharat is a Surface Logging Domain Champion at Schlumberger. He is specialized in formation evaluation using surface measurements and provides technical support primarily in advanced mud gas measurements and drilled cutting analysis. Previously he held various roles in surface logging with Geoservices in Asia & Europe. He has over 20 years of experience in surface logging and has co-authored technical papers and delivered technical courses for various societies.

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Automated fluid characterizing technique based on ML and fluid phase diagram in real time

Annup Hunnur, Baker Hughes

Abstract

Characterizing the fluids in any reservoir is one of the critical things for creating a well-defined development plan. Some of the important factors in this characterization is defining the fluid composition and its representation in an Equation Of State (EOS) to use for reservoir studies.

While the acquisition systems, be it Wireline / LWD systems, have improved to the point that a very clean reservoir formation fluid can now be acquired, the time it takes for labs to analyze these. To aid this issue, a real time methodology for determining the EOS using the results from formation testing and sampling tool has been developed. The technique is based real time measurements of in-situ density and sound speed of the live fluids along with associated pressure and temperature. One of the important considerations is to exclude the influence of any contamination within the fluid to the calculated EOS. A newly developed digital technique to quantify the contamination with its associated uncertainty is used to remove the effects of oil-based mud filtrate contamination in EOS calculation.

These results along with the measurements of bubble point and dew point can thus provide details fluid characterization in real time as the fluid is being sampled.

Biography

Anup Hunnur is a Global Advisor for Formation testing and sampling in Baker Hughes Company in Houston He has been with the company for 15 years and has experience working around the world. In this role, he provides technical support, mentoring and trainings in all aspects related to testing and sampling. He is also involved in new tool development efforts, software development efforts as well as in developing new geoscience products to improve the testing and sampling portfolio. Anup holds a MS degree in Petroleum Engineering from University of Oklahoma, U.S.A. and BE in Chemical Engineering from Bangalore University, India.

Automated Workflow to Indicate Reservoir Connectivity Through Asphaltene Equilibrium

Melanie Jensen, Schlumberger

Abstract

The evaluation of downhole fluid analysis (DFA) measurements of asphaltene gradients provides the ability to determine the extent of asphaltene equilibrium and the operative reservoir fluid geodynamics (RFG) processes. Typically, equilibrium of reservoir fluids indicates reservoir connectivity, a primary concern in field development planning. Currently, the modeling of asphaltene gradients is done through the manual evaluation of the DFA optical density gradients. The optical density measurements are fit to an equation of state (EOS), such as the Flory-Huggins-Zuo EOS, and evidence for asphaltene equilibrium is concluded if the inferred asphaltene diameter corresponds to that of the Yen-Mullins model for asphaltene composition.

In this work, we present an automated Bayesian algorithm that proposes multiple hypotheses for the state of asphaltene equilibrium. The proposed hypotheses honor DFA measurements; physical models for asphaltenes in equilibrium, such as the Yen-Mullins model; and prior domain knowledge of the reservoir, such as geological layers, faults, and flow units. The leading hypotheses are reported, and evidence for or against asphaltene equilibrium is concluded from inferred quantities. Our proposed method provides a faster way for domain experts to explore different reservoir realizations that honors the theory of asphaltenes gradients and previous knowledge about the reservoir.

We verify our novel method on three case studies that are undergoing different RFG processes through comparison of the interpretation done by domain experts. While there are many reservoir complexities associated with each case study, we focus on whether the underlying RFG process corresponds to the asphaltenes in equilibrium. The first case study is a light oil reservoir in the Norwegian North Sea that is mostly in fluid equilibrium with exceptions at the flanks. The second case study is a black oil reservoir that has undergone a fault block migration after the reservoir fluids had a chance to achieve equilibrium. The last case study is black oil reservoir in quasi-equilibrium due to biodegradation in the lower portion of the well.

Biography

Melanie Jensen is a Research Scientist with Schlumberger-Doll Research. Her research involves development of Bayesian method for analysis of fluid data. She is interested in the application of Bayesian statistics and machine learning to uncover properties of a reservoir and uncertainty quantification. She obtained her PhD from Tulane University in 2019 where she applied and developed statistical methods within the field of microbiology.