Advancing Mudlogging Through Digital Technology: Methods and Use Cases

Seminar

Friday 5th December 2025

Location: SLB, 1 Rue Becquerel, 91240, Clamart.

09:45- 17:00

The SPWLA France chapter invites you to a day of enriching discussions on mudlogging aspects.

The program includes talks on the following topics:

Formation Evaluation with Mudlogging

New Technology and Automation

Integration of Subsurface Logs with Mudlogging

Case Studies and Applications in O&G and Hydrogen Exploration

THEME: **Advancing Mudlogging Through Digital Technology: Methods and Use Cases**

Start	End	Duration		Presentation title	Presenter	Company
09:45	**10:00**	**00:15**		**Welcome & Introduction**		SPWLA France
10:00	10:30	00:30		A New Industry Standard for Surface Formation Evaluation: Real-Time Confidence Ranking of Mud Gas Data	Ivan Fornasier	SLB
10:30	11:00	00:30		Fluid column characterization and modeling from quantitative mud gas	Emmanuel Caroli	TotalEnergies
11:00	**11:30**	**00:30**		**Break**		
11:30	12:00	00:30		Mud flow meters - The Ultimate Kick Detection System	Filippo Casali	Geolog
12:00	**13:30**	**01:30**		**Lunch break**		
13:30	14:00	00:30		Advanced answer products from molecular C_{1-5}, H_2, He and isotopic C_{1-3} mud gas logging and their drilling-related challenges	Dariusz Strąpoć	SLB
14:00	14:30	00:30		Continuous Real-Time Detection of H_2, He, and ^{222}Rn WhilevDrilling DIVE-1 Boreholes (ICDP) Indicates Deep Fracture Fluid Migration in Crystalline Rocks	Mai-Linh Doan	University of Grenoble-Alpes
14:30	**14:50**	**00:20**		**Break**		
14:50	15:20	00:30		Pore Pressure Prediction Workflow And Procedures For Mitigating Drilling Challenges: Pre-Drill, While Drilling, And Post-Drilling	Vishwanathan Parmeshwa	Excellence Logging
15:20	16:20	01:00		Automated Lithology: Connected Solutions for remote lithology Interpretation from drilled cuttings (Presentation & Demo)	Karim Bondabou	SLB
16:20	**16:30**	**00:10**		**Closing remarks**		SPWLA France

A New Industry Standard for Surface Formation Evaluation: Real-Time Confidence Ranking of Mud Gas Data

Ivan Fornasier, SLB

D. Strąpoć, I. Fornasier, G. Cera, L. Cezard, B. Pointillart, J. Audroing, D. Lockyer, P. Ferrando

Abstract: Surface formation evaluation (SFE) provides a continuous geochemical log of encountered fluids along a well, enabling critical real-time decisions such as geo-steering and optimizing sampling and testing programs. The Mud Gas Advisor (MGA) workflow introduces a real-time Interpretation Confidence Index (ICI) to assess the representativeness of mud gas data relative to reservoir fluid composition and to recommend corrective actions or hardware upgrades.

MGA evaluates gas chain attributes—such as extractor type (heated vs. non-heated), gas corrections (recycling, extraction efficiency), and compound range analyzed—against environmental and drilling conditions, including mud properties and atmospheric factors. Based on these inputs, MGA computes the ICI for quality-controlled gas data, indicating how closely the measured C1–C5 composition reflects actual reservoir fluids. This confidence metric supports informed decisions on fluid typing ratios (e.g., wetness, character) and whether data is suitable for interpretation or requires enhancement.

Unlike traditional hardware QC, MGA provides a dynamic confidence measure independent of hardware type, accounting for operational and environmental variability. Post-well analysis identifies key factors reducing ICI—such as condensation of heavier hydrocarbons, lack of heated extraction, and mud contamination—and suggests digital corrections and hardware improvements for future operations. MGA can also be applied retrospectively to older or third-party datasets, provided essential parameters are available.

Field applications demonstrate that advanced gas chains (heated degassers, modern analyzers) significantly improve ICI compared to standard systems, enabling accurate fluid typing (e.g., wet gas vs. dry gas) and reducing interpretation risk. MGA thus establishes a new industry standard for transparent, confidence-ranked mud gas interpretation, enhancing risk awareness and decision-making during drilling and completion planning.

Speaker

Ivan Fornasier began his career with Geoservices in 1995 as a Mudlogging Field Engineer. In 2003, he transitioned to the role of Advanced Mud Gas Field Engineer. From 2009 to 2011, he served as a Mud Gas Specialist at the Geoservices Expertise Center in Paris. Between 2011 and 2015, he held the position of Formation Evaluation Interpretation and Development Manager. Ivan currently serves as Product Champion for Surface Gas and Isotope Logging Services at SLB.

He holds a Master's degree in Geology from the University of Naples "Federico II" in Italy and has authored and co-authored several scientific publications.

Fluid column characterization and modeling from quantitative mud gas

Emmanuel Caroli, TotalEnergies

Co-author: Valérie Burg, TotalEnergies

Abstract: Deriving fluid properties contunuously along a section from quantitative mud gas is an attractive option as such data are systematically acquired on all wells at reasonable cost. Indeed, mudlogging has turned mud gas measurements to a sufficient level of reliability to consider the C1 to C5 (C6) surface gas compositions as a reliable picture of the hydrocarbon fluid content of the mud. Provided all drilling artifacts are properly addressed, it comes to a real continuous fluid composition log along the well. Such a log is however limited to the light end of the fluid and, consequently, cannot provide straightforward conclusions on the fluid nature and properties. The development presented in this paper consists in associating locally decontaminated fluid measurements and the corresponding stacked quantitative mud gas data to fit a chemical and physical fluid model. This latter is a simplified average molecular fraction pattern law that statistically describes the abundance of each cut based on compositional invariants, expresses the overall fluid column equilibrium and associates volumetric properties to each cut. All the unknown parameters can be auto-adjusted by inversion provided GOR and downhole density are provided by different techniques. Then, the model can predict all fluid properties (such as full composition, molecular weight, FVF, API...) and propagate them along the well section thanks to the quantitative mud gas data alone. This paper shows an application of the method to a recent offshore appraisal campaign in a highly compartmentalized multi-reservoir field where fluid variability was partly solved with quantitative mud gas.

Speaker

Emmanuel Caroli is a formation evaluation senior specialist with TotalEnergies. He graduated from the Ecole Normale Supérieure, Ecole des Mines de Paris, and the IFP School in physical geology, petroleum geology, and sedimentary basin modeling. He joined the TotalEnergies group in 2003 as a mineral geochemist. After several positions abroad in exploration operations, he was appointed in 2009 at the scientific headquarters in Pau as a petrophysicist and welllog analyst. He is now working in formation evaluation R&D, innovation, and digital solution developments.

Mud flow meters - The Ultimate Kick Detection System

Filippo Casali, Geolog

Abstract: A precise understanding of mud flow behavior is fundamental to safe and efficient drilling. Flow meters play a critical role in detecting kicks, losses, and circulation anomalies—events that can rapidly escalate if not identified in time. In challenging scenarios such as high gas-cut returns, high-solids mud systems, MPD operations, or deepwater environments with narrow pressure windows, accurate flow measurements become indispensable to maintain well control and protect both personnel and assets.

Today a new type of advanced flow meters has been patented and engineered to deliver accurate, real-time measurements even under the most demanding drilling conditions. Developed entirely in-house, the system addresses long-standing limitations in monitoring heterogeneous mud flows, providing reliable flow, density, and temperature data during critical operations. By improving measurement accuracy across all phases of drilling, it enhances early kick detection, strengthens well-control decision-making, and supports overall operational safety and efficiency.

Speaker

Filippo Casali is GEOLOG's Country Manager for Italy and Account Manager, while also supporting the European team as Business Development Manager. He began his career as a Mud Logger in 2013 and, after gaining experience within the R&D Department, moved into the role of Domain Expert for Inorganic Geochemistry services. In 2022, he transitioned to the Operations Department, where he became responsible for business development, overseeing operations, and meeting targets related to profit, revenue, cash flow, and service quality.

He holds an M.Sc. in Applied Geological Sciences and is a member of LPS, SPWLA, EAGE, and board member of the SPE Italian Section.

Advanced answer products from molecular C_{1-5}, H_2, He and isotopic C_{1-3} mud gas logging and their drilling-related challenges

Dr Dariusz Strąpoć, SLB

I. Fornasier (SLB), L. Gerbaud (Mines Paris)

Abstract: Obtaining reliable while-drilling continuous logs of basic, yet representative geochemistry of the reservoir fluid has been growing in importance as hydrocarbon exploration extends to more challenging downhole conditions and more complex petroleum system scenarios. Fluid alterations, such as mature gas recharge, mixing with preexisting biogenic methane, or from fluid biodegradation itself can overprint or at least bias classical interpretative proxies that use molecular or isotopic C_{1-5} composition. Such alteration can influence key reservoir fluid properties, including gas/oil ratio (GOR), viscosity, mobility, and phase behavior. Additionally, in harsher drilling conditions, drillbit metamorphism (DBM) has become a notorious problem for interpretation of mud gas data by adding artificial alkanes and shifting their bulk isotopic composition, especially in oil-based mud (OBM), which is used in the majority of reservoir sections. Our experimental work in drilling laboratory with OBM, delivered DBM-correction of molecular (C_{1-5}) and C-isotopic mud gas data (C_{1-3}). Once the data is determined to be representative of the reservoir fluid, fluid properties such as thermal maturity and GOR are calculated, but not via a direct conversion of $\delta^{13}C$-C_2, which might work only for unaltered fluid. Instead, the resulting initial GOR is modified proportionally to the magnitude of the fluid alteration flags, i.e., mixing with biogenic C_1 (digitalized flag based on a modified Schoell diagram) and mature gas recharge flag inferred from relative inconsistencies of vitrinite reflectance equivalents (VRE) among C_{1-3}.

H_2 and helium (He) logging have been introduced in hybrid well for oil and gas and in dedicated exploration for either of the two inorganic gases. A mass spectrometer has been calibrated for quantitative H_2 and helium logging and degassing strategy selected. Additionally, the drilling laboratory experiments help us investigate sources of artificial DBM-generated hydrogen in different drilling fluids and with different rocks. This has profound implications in understanding mud-gas hydrogen to decipher its indigenous richness. Our experience in identifying DBM-H_2 contributions in many wells has been growing over last few years and helps in ongoing drilling campaigns around the world.

Speaker

Dariusz Strąpoć began his career with Geoservices in 2012 as Formation Evaluation Interpretation and Development Senior. Then as from 2015 as Domain Champion for Surface Gas and Isotope Logging Services, and since 2022 advanced to SLB Principal in Surface Logging Formation Evaluation SME. He holds a Master's degree in Geology from the University of Wrocław in Poland and PhD in Geochemistry from Indiana University, Bloomington, IN, USA. After studies he spent three years at ConocoPhillips in Subsurface Technology team in Houston, TX, USA and one year as independent consultant. He has authored multiple scientific and patent publications and is active in the geochemistry community participating in many conferences and editorship of geochemical journals.

Continuous Real-Time Detection of H_2, He, and ^{222}Rn While Drilling DIVE-1 Boreholes (ICDP) Indicates Deep Fracture Fluid Migration in Crystalline Rocks

Mai-Linh Đoan, University of Grenoble Alpes

H. Dutoit , L. Truche, F. V. Donze , T. Wiersberg, J. Li , A. Greenwood, E. Caspari , N. Lefeuvre1, J. Dominique, S. Auclair, L. Masci1, G. Hetenyi , M. Venier, O. Muntener, and ICDP DIVE Science Team

Abstract: The identification and real-time monitoring of geofluids during drilling is crucial for safe drilling operations and can provide valuable insights into reservoir properties and fluid migration. While mud gas logging is well established in oil and gas exploration, recent interest in natural hydrogen (H_2) and helium (He) exploration has prompted the need for improved mud gas logging techniques for continuous wireline coring in crystalline bedrock. The detection of both H2 and He is particularly useful when exploring these two commodities but also for identifying deep fluid migration notably in crystalline bedrock. This study presents the results of mud gas logging of O_2, N_2, ^{40}Ar, ^{38}Ar, ^{36}Ar, CO_2, CH_4, H_2, He, and ^{222}Rn from two boreholes (909.5 and 578.5 m deep) drilled in the Ivrea-Verbano Zone (Northern Italy) as part of the DIVE-ICDP project.

Comparison with data from geophysical logging showed that gas peaks correlate well with variations in the physical characteristics of the well fluid, indicating zones of fluid inflow. Real-time gas monitoring proved to be valuable for identifying deep gas migration and aiding decision-making. Despite its potential, this technique faces challenges, such as distinguishing between formation-derived and drilling-induced gases. Complementary analyses, including isotopic studies, are recommended to refine source identification. Nevertheless, the correlation of He and H_2 with CH_4 and CO_2 provides initial insights into their possible origins, making this method a promising tool for exploring H_2 and He gases in deep geological formations.

Speaker

Mai-Linh Đoan works on the mechanisms of active faults, measuring their hydraulic and thermal properties, as well as the stresses surrounding them directly in the field. Deep drilling provides unique data to understand earthquake mechanisms. Mai-Linh has participated in numerous international projects involving the instrumentation of active faults, for example: (1) the Aigion fault in the Gulf of Corinth, (2) the Chelungpu fault, (3) the NantroSEIZE drilling project in the Nankai subduction zone off the coast of Japan, (4) the Deep Fault Drilling Project (DFDP) on the Alpine Fault in New Zealand.

Pore Pressure Prediction Workflow And Procedures For Mitigating Drilling Challenges: Pre-Drill, While Drilling, And Post-Drilling

Vishwanathan Parmeshwar, Excellence Logging

Abstract: Pore pressure prediction plays a critical role in well planning, drilling safety, and cost management. In geologically complex and overpressure environments, such as deep formations in Kuwait, accurate prediction has become increasingly challenging and prone to error. The objective of this study was to develop a practical, improved-accuracy, and field-validated pore pressure prediction workflow tailored to geological challenges by integrating available pre-drill, while-drilling, and post-drill data into a dynamic model that supports proactive well planning and real-time decision-making.

A key focus is to establish a standard operating procedure for pore pressure prediction, risk identification, and mud weight management that is uniformly applicable across all future drilling campaigns. The implementation of this workflow led to a measurable improvement in drilling performance, safety, and cost optimization by formalizing a cross-disciplinary and data-integrated approach. This model has become an integral part of the KOC's drilling optimization strategy.

Speaker

Vishwanathan Parmeshwar is a Subject matter expert in Excellence Logging, globally overseeing the delivery of advanced drilling solutions. Based in Colombes, France, his experience spans 35 years in drilling operations and research. Mr. Parmeshwar holds a Master of Science degree in geology. He is the author of 23 patents and a recipient of an Inventor Award. His experience includes Geomechanics study, data analytics, predictive analysis, and he was part of the group that developed advanced drilling rigs. He actively contributed to the development of Rig sensor stewardship guidelines under the patronage of IADC.

Automated Lithology: Connected Solutions for remote lithology Interpretation from drilled cuttings

Karim Bondabou, SLB's Surface Geology Product Champion

Abstract: SLB's Surface Geology Product Champion, Karim Bondabou, will present Automated Lithology—an innovative service designed to overcome data-specific challenges by delivering consistency, standardization, and accuracy in the digitization, description, and analysis of lithology from drilled cuttings. This solution also transforms the operating model by enabling remote lithology description.

Following the presentation, there will be a demonstration of the equipment used to analyze cuttings.

Speaker

Karim Bondabou is a surface geology product champion at SLB, based in France. He currently leads the development and introduction of new technologies related to surface formation evaluation on drilled rocks. Karim has collaborated on the development of cutting measurements, as well as the deployment of these techniques and data interpretation. He received his MS degree in geology with a specialization in geological reservoir characterization from the University of Sciences and Technology, Montpellier, France in 2008