Summary of the April 8, 2026, SPWLA Nuclear Logging SIG 2026 Spring Technical Meeting

Prepared by R. J. Radtke and A. Badruzzaman

Overview

This SIG Technical Meeting was held virtually on April 8, 2026. The meeting consisted of a summary of SIG activities this year by the chairman followed by three technical presentations. Each presentation was 20 minutes long with 10 minutes set aside for questions. The agenda was:

- Introduction by A. Badruzzaman (Consultant and Chair of the Nuclear Logging SIG)
- C. Morelli (SLB and Kyushu University), Automatic Geological Facies Analysis in Crust-Mantle Transition Zone - Utilizing Nuclear Logging Data with Borehole Image (Petrophysics 65(3), 342 (2024)).
- Y. Kim (Baker Hughes), Distinguishing CO2 and Hydrocarbon Gas Using Pulsed Neutron Logs for CO2 Storage Projects in Depleted Gas Reservoirs (SPWLA-2025-0083).
- J. Wang (Halliburton), A Novel Pulsed Neutron LWD Geochemical Logging Tool with Sigma and Direct Carbon Measurements (SPE 228060).

The meeting was attended by an international group of 41 people from operating companies (14), service companies (19), consultants (7), and universities (1). A complete list of attendees may be found in the Appendix.

The following sections contain the abstracts of each presentation, a biographical sketch of the presenter, and a summary of the questions and answers that followed each presentation.

Introduction

Ahmed Badruzzaman (Consultant and Chair of the Nuclear Logging SIG).
ahmed.badruzzaman@gmail.com; ahmed.badruzzaman@berkeley.edu

Abstract

The SPWLA Nuclear Logging SIG would like to welcome the participants to this technical meeting and to thank them for their participation in the SIG.

Many thanks are also in order to the members of the SIG's Executive Committee. First, we would like to thank R. J. Radtke, Vice-Chair of Technology, for organizing this meeting. Second, we would like to bid farewell to retiring EC members Feyzi Inanc (Baker Hughes), Cornelis Huiszoon (SLB), and Richard Pemper (Weatherford) and to thank them for their dedicated service. Finally, we would like to welcome new EC members Pingjun Guo (ExxonMobil) and Amr Serry (ADNOC).

In 2026, the SIG will focus on three activities. The first is this meeting. Additionally, we have given input to the SPWLA Student Award Competition, which we hope will eventually lead to an award for best nuclear paper. Lastly, we are organizing a workshop as part of the SPWLA Annual Symposium entitled "Replacing Radioactive Sources Used in Nuclear Logging - Current State and Potential Future", which will be held on Sunday, May 17. The Symposium will take place in Lake Conroe, TX.

Expanding on the last item, the workshop on source replacement will feature speakers from the U. S. Government, the Oil and Gas Industry, and the U. S. National Laboratories. Source risk and the government's role in mitigating it will be covered by Monica Lemmon and possibly Hank Zhu of the National Nuclear Security Administration (NNSA), a part of the U.S. Department of Energy. Speakers from industry include Sicco Beekman (SLB), Weijun Guo (Halliburton), Marie-Laure Mauborgne (SLB), and R. J. Radtke (SLB), representing the service company perspective, and Pingjun Guo (ExxonMobil) and Amr Serry (ADNOC), representing the operator perspective. From the national labs, Kelly Jenkins and/or Jeremy Patterson (Oak Ridge National Laboratory) will discuss alternative technologies which could replace AmBe neutron sources, and Ann Archer (Pacific Northwest National Laboratory) will cover technologies for monitoring logging sources. This diverse group of speakers should provide a comprehensive overview of the present state of affairs for source replacement, and all are encouraged to attend.

About the Presenter

Ahmed Badruzzaman has studied downhole nuclear techniques for over 45 years during R&D tenures in Chevron, Sandia National Laboratories, and Schlumberger-Doll Research. After retirement from industrial R&D, he has been a consultant to the US DOE NNSA as a subject matter expert and is teaching at UC Berkeley. He is the author of over 50 papers, two US patents, and an upcoming textbook on Nuclear Logging. He is a Fellow of American Nuclear Society, a two-time Distinguished Lecturer/Speaker of both the SPE and the SPWLA, and he was awarded the SPWLA Gold Medal in 2025, which is the Society's highest technical recognition. He holds a PhD in Nuclear Engineering and Science from Rensselaer Polytechnic Institute, Troy, NY. Most importantly for this gathering, Ahmed chairs the SPWLA Nuclear Logging SIG.

Automatic Geological Facies Analysis in Crust-Mantle Transition Zone - Utilizing Nuclear Logging Data with Borehole Image

Chiaki Morelli (SLB and Kyushu University)
CNagaoka@slb.com

Abstract

This presentation introduces an integrated workflow utilizing geochemical spectroscopy logs to characterize the complex lithological and mineralogical variations across the crust–mantle transition drilled in the Oman Drilling Project by ICDP (International Continental Scientific Drilling Program). Spectroscopy logs can directly quantify major elemental concentrations, which provide a robust foundation for distinguishing dunite, gabbro, and harzburgite intervals.
Maehara et al. (2021) validated spectroscopy-derived elemental curves against core XRF measurements, then conducted mineralogical quantitative interpretation using Si, Mg, Fe, Ca and Al curves as inputs. The result of mineral composition matched well with core analysis results.

By combining spectroscopy log with borehole image log, we performed automatic geological facies analysis to optimize lithological classification and operational efficiency (Morelli et al., 2023; 2024). The elemental curve inputs (Fe, Ca and Si) were selected through PCA (Principal Component Analysis) which was useful to identify suitable input elements from available large dataset. Additionally, an integrated true color borehole image was generated by applying the Pan-sharpening method to inject RGB color assignment (Fe: red, Ca: blue, Si: green) into high-resolution borehole images (Morelli et al., 2025). This approach can visualize mineralogical and texture changes, then successfully highlight serpentinized dunite zones by an iron-rich red color with altered fractured texture, which may represent potential natural hydrogen source rocks.

Overall, spectroscopy logs significantly improve formation evaluation when combined with borehole images. The methods presented here are especially useful when full coring is challenging, such as in future ultra-deep scientific drilling for Mohole to Mantle project planned by IODP (International Ocean Discovery Program).

About the Presenter

Chiaki Morelli is a senior borehole geologist with SLB based in Nagaoka, Japan. She joined SLB in 2007 and has been leading and involved in various types of borehole image data processing and analysis of diverse reservoirs including oil and gas in sandstone and volcanic rock, methane hydrate, geothermal, hydrothermal, CCS and scientific drilling. She holds an MSc in science and technology from Hirosaki University in Japan and is currently a late-stage Ph.D. candidate at Kyushu University.

Questions and Answers

Several minutes of discussion followed the presentation. Below are the questions posed verbally and in the meeting chat. Due to time, some of these questions were not addressed (or at least the answers were not recorded), and the audience was invited to follow up with the presenter off-line.

- Are the K and Al shown in the logs from capture or inelastic spectroscopy? For the tool used, both are from capture.
- How good is K from spectral natural gamma ray (SGR) vs. (n-gamma)? K from SGR is more precise generally, but both have the same accuracy.
- How did you deal with the measurement-volume difference between the high-resolution image vs spectroscopy averaging of formation response? No special processing was employed.
- The mineralogy color image and static image did not tally very well. Do you have any idea why?

Distinguishing CO2 and Hydrocarbon Gas Using Pulsed Neutron Logs for CO2 Storage Projects in Depleted Gas Reservoirs

Yonghwee Kim (Baker Hughes)
yonghwee.kim@bakerhughes.com

Abstract

Monitoring carbon dioxide (CO2) injection and storage is critical for geological CO2 storage projects. Among the various monitoring technologies, pulsed neutron well logging provides insights into the CO2 injection and storage profiles of near-wellbore formations on a well-centric (or well-to-well) basis. Using pulsed neutron well logs and stochastic forward models, we present a technique for differentiating between CO2 and hydrocarbon gas (i.e., methane or CH4) under subsurface conditions when CO2 is injected into depleted gas reservoirs.

We made certain assumptions regarding the depleted gas reservoirs to quantify the CO2 and CH4 volumes separately. First, the water volume in the formation remained unchanged after CO2 injection. Subsequently, the CH4 volume decreased with CO2 injection, but the total volume of the two fluids remained constant. Finally, variations in the formation properties, and the attributes and behavior of each fluid were negligible. To compute the saturation of each component, we integrated (1) the inelastic gamma-ray count rate ratio-based measurement from a three-gamma-ray-detector-equipped pulsed neutron logging tool and (2) the respective stochastically simulated tool responses considering well and formation specifications and developed an advanced multiphase saturation analysis algorithm.

Monte Carlo N-Particle (MCNP) simulations produced forward models for the evaluation of irreducible water- and CH4-filled formations with porosities ranging from zero to 40%. The predicted tool responses were at maximum ratio-measurement values when the formations were filled with water and CH4. The minimum predicted tool responses occurred when the porous media were filled with CO2 and irreducible water. Furthermore, the tool responses for formations with varying CH4 and CO2 volumes were simulated, expanding the characterization of the ratio measurement. The correlations between the ratio measurement and CO2 saturation at varying porosities were determined using the generated MCNP models. Forward modeling-based in-situ CO2 saturation and ratio-measurement correlations at different porosities enable the determination of the saturation of CO2 and CH4.

Previous pulsed neutron data analysis methods for monitoring CO2 have been limited to estimating the total gas volume without distinguishing CO2 from a hydrocarbon gas. When the water in the porous media of depleted gas reservoirs is irreducible, the proposed method allows the calculation of the CO2 and CH4 volumes separately. Accurate well-centric CO2 and CH4 saturation data during the post-injection phase can be used as conditional data to update field-scale reservoir simulation models

About the Presenter

Yonghwee Kim is a Senior Principal at GaffneyCline energy advisory, Baker Hughes. For more than 17 years, he has worked on cased-hole well logging data analysis and interpretation, primarily with pulsed-neutron, production, and cement bond logs. He holds a BS in Chemical Engineering from Yonsei University and an MS in Petroleum Engineering from The University of Texas at Austin.

Questions and Answers

As in the preceding talk, several minutes of discussion followed. Below are the questions posed verbally and in the meeting chat. For questions which were not answered, the audience was invited to follow up with the presenter off-line.

- This presentation is a discussion of a workflow for distinguishing CO_2 from methane. Is the pulsed-neutron technology by Baker Hughes able to measure CO_2 in aqueous or miscible water phases? That remains an open question.
- Any impact of permeability on the answers? 50% IRR, above the aquifer.
- Has this workflow been tested in the field? No, this work is still conceptual. At the moment, we are finishing the modeling and building the workflow. The next phase will be to expand to implementation.

- The temperature effect (cooling) was not used in this simulation, was it? No temperature effects were included in the present workflow, though they could be. In general, temperature could affect the density. A participant noted that cooling could clog pores and reduce permeability.
- Is the initial gas saturation from a pulsed-neutron log needed for distinguishing gas (CH_4) from CO_2? A baseline log is not needed but is preferred.
- Wondering about the challenges of timelapse over 24 years, what is the impact of possible changing fluids in the wellbore, and if different tools can be used or the same tool is preferred?

A Novel Pulsed Neutron LWD Geochemical Logging Tool with Sigma and Direct Carbon Measurements

Jiaxin Wang (Halliburton)
Jiaxin.Wang@halliburton.com

Abstract

A novel 6.75-in. logging-while-drilling (LWD) geochemical tool has been developed for accurate lithology, mineralogy, well- placement, and geosteering applications in complex reservoirs. This LWD tool utilizes capture and inelastic gamma rays induced by a pulsed neutron generator to provide real-time formation elemental and mineralogical concentrations, sigma, and direct carbon measurements. These measurements provide essential information for an accurate petrophysical interpretation and aid timely decision-making for superior drilling performance.

The new LWD tool is based on an advanced 14-MeV pulsed neutron generator and a high-resolution Lanthanum Bromide (LaBr3) gamma-ray scintillator coupled with a ruggedized photomultiplier tube (PMT). The generator-sensor package is situated inside a superalloy drill collar with a boron sleeve over the sensor section. The raw data is stored in memory and processed in real time. The inelastic and capture energy spectra are fitted to elemental standards and the weight concentrations are derived from the yields through oxide closure and special calibrations. The results are processed into minerals and lithologies. A dual-exponential fit to the time decay spectra determines sigma.

The tool was characterized and tested using approximately 30 natural and artificial lab formations as well as temperature, pressure, shock, and vibration testing facilities. The tool elemental standards and sensitivities were derived using a combination of lab measurements and Monte Carlo simulation. Drilling tests were conducted at a test rig using a bottomhole assembly (BHA) including a rotary steerable system (RSS) and a typical triple combo to drill 2,900-ft through the Glenn Rose Limestone, Pearsall Shale, Hosston-Travis Dolomite, and the Cotton Valley Sandstone formations. Several sections were wiped multiple times with the same and different tools to assess real-world measurement repeatability. The tool answers were also compared to a full suite of open-hole wireline logs which were logged in the same well shortly after the drilling was completed. In addition, 48 cores from this well were obtained with wireline side-wall coring runs and were analyzed with laboratory standard procedures. The analysis included mineralogy, major elements, trace elements, and total carbon. This paper presents results from laboratory formations and logs recorded in the test well to illustrate tool performance.

The new tool features a large detector volume and a precisely controlled neutron generator, coupled with high-speed electronics and advanced controls. The development process included

comprehensive characterization and testing that included mock-up and prototype tools, a thorough computer modeling and simulation effort, and development of precise data-processing algorithms. The result is the first LWD geochemical logging tool to report directly measured carbon from the inelastic energy spectrum.

About the Presenter

Jiaxin Wang is a Scientific Advisor in Halliburton's sensor physics group, based in Houston, TX. He earned his Ph.D. in nuclear engineering from North Carolina State University (NCSU) in 2011. Before joining Halliburton in 2017, he worked at Schlumberger as a senior tool physicist. His present work focuses on novel radiation measurement systems, nuclear logging tool designs, modeling / characterization, and algorithm development.

Questions and Answers

Several minutes of discussion followed. Below are the questions posed verbally and in the meeting chat. For questions which were not answered, the audience was invited to follow up with the presenter off-line.

- What reactions were used to determine the concentrations of K, Al, and Mg? All elemental concentrations except for C are from capture. K from capture agrees well with K from SGR logs. A general comment from A. Badruzzaman: Elemental logs by vendor tools usually do not appear to clarify the source reaction from which the reported yields are determined; this should be rectified.
- Did you use any offsets in the computation of mineral volume? If so, did you use the same offsets in wireline (WL) and logging-while-drilling (LWD) spectroscopy? No offsets were used in mineralogy for core or WL comparisons.
- Approximately what percentage of the signal is from the tool? The tool background is small in capture due to the boron shield on the collar. In inelastic, the shielding is not very effective, and so the tool background is much larger.
- Why not use a $CeBr_3$-based detector as in your cased-hole tool? $CeBr_3$ does not offer much benefit compared to $LaBr_3$ in this application.
- Can you share which WL tool was used for the correlation? It looks like Mg and Al are not matching in several sections, while the LWD–core comparison shows better agreement. The WL tool was the GEM tool. This tool has an AmBe source with a BGO detector; the LWD tool in this paper has a pulsed D-T generator source with a $LaBr_3$ crystal.
- Is the detector offset optimal?

Appendix: Attendees

Last Name	First Name	Affiliation
Adeyemo	Dapo	Chevron
Badruzzaman	Ahmed	Pacific Consultants and Engineers
Banzarov	Bair	Baker Hughes
Barnes	David	Chevron
Bhuyan	Priyanuz	SEEPCO
Carter	William	Weatherford
Claverie	Michel	Consultant
Crawford	Jeffrey	Halliburton

Deltour	Alexander	Lucent Petroleum
Djordjevic	Obren	Ovintiv
Eghbali	Ali	Baker Hughes
Elsisi	Zarif	Gupco
Ganguly	Sanchita	EBN
Gendur	Jason	SLB
Guo	Weijun	Halliburton
Hagiwara	terry	Terry R&D
Han	Xiaogang	BP
Hathon	Lori	University of Houston
Hemingway	James	Consultant
Hossein Zadeh	Ahmad	Equinor
Jeanneau	Philippe	Sodern
Kos	Bor	Baker Hughes
Kumar	Allam Sudhir	ONGC
McGlynn	Ian	Weatherford
Mekic	Natasa	Petrodexia
Nardiello	Roberto	Baker Hughes
Nishi	Masatoshi	INPEX
Palencia	Clara	ConocoPhillips
Parker	Tim	Halliburton
Radtke	R. J.	SLB
Ramazanov	Rizvan	BP
Rao	Sanjeev	Weatherford
Ray	Kaveri	Halliburton
Rodrigues	Patricia	SeisPetro
Ruterbories	Daniel	Baker Hughes
Schmid	Gregory	Halliburton
Simpson	Gary	Unknown
Valouiski	Konstantin	Roke Technologies
Vogt	Andreas	Baker Hughes
Xu	Tao	SLB
Zulkipli	Siti Najmi Farhan	Petronas