8 - 10 MAY 2023 · AL-KHOBAR, SAUDI ARABIA

2ND EDITION: **AAPG/SPWLA**

LOW RESISTIVITY RESERVOIRS: PATH TO EXPLORE, DISCOVER AND DEVELOP

WORKSHOP BROCHURE

WHAT TO EXPECT FROM THE AAPG EXPERIENCE

The American Association of Petroleum Geologists (AAPG) and our suppliers, venues and services partners are committed to providing a clean and safe environment and experience for all our event participants. We remain alert to COVID-19 risks and are closely following and adapting to all applicable health and safety guidelines. While conditions vary between countries, cities, municipalities, and facilities, safeguarding measures you may encounter at AAPG events include physical distancing and masking, readily available hand sanitizer, enhanced cleaning and disinfecting protocols, temperature health checks and screenings, minimized touchpoints and cashless payment options.

As personal safety is a shared responsibility, we ask that all participants ensure that they are feeling well and in good health, with no fever or other symptoms related to COVID-19, before showing up at an AAPG event. Any specific delegate obligations will be published in pre-event communications and clearly displayed on signage throughout our venues. Given the ever-changing nature of the pandemic recovery, registrants will receive regular updates and instructions concerning the latest health and safety requirements.

Please note that AAPG will be regularly monitoring and updating information concerning travel and entry requirements to the workshop.

TECHNICAL PROGRAM COMMITTEE

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WORKSHOP OUTLINE

Workshop Overview

"Wait! There is a short cut. Turn right from here". That's probably the sound of an electric current bypassing the resistive hydrocarbons, in a maze or network of porous media, when traveling from transmitter to receiver. Short cuts don't always serve our needs, as it can mask humongous reserves and development opportunities from us. We call that phenomenon as low resistivity pay. However, on the other hand, resistivity-related missed opportunities can happen with low contrast, where resistivity has no short cuts under different circumstances.

In the past century, the world has witnessed a successful long streak of large field discoveries and structures. Along with that, challenges in identifying and evaluating the low resistivity and low resistivity contrast pays with the conventional log analysis has risen to surface. In this workshop, we come together for a common target towards building and strengthening our knowledge in identifying, characterizing and modeling low contrast and low resistivity pays. Ultimately, we aim to gear ourselves with state of the art and unconventional skills to look at our existing and new reservoirs with different binoculars to hopefully unlock new hydrocarbon reservoir potentials and achieve another streak of discoveries.

We strive to have as much as possible from both industry and educational institutions to come together and share our years of experience in a such collaborative and knowledge exchange session to tap on low resistivity and low contrast issues from different and multi-disciplinary angles. With that, this workshop will serve the participants need with the up to date advancements in describing and characterizing low resistivity and low contrast pay, and eventually, maximize resources.

Benefits of Attending

The workshop is an opportunity for attendees to receive up-to-date knowledge on the different approaches for evaluating the complex low-resistivity and low-resistivity-contrast payformation from the exposure to regional and global casestudies and the state-of-the-art technologies being employedas part of the evaluation. The forum will facilitate to make anetwork with subject matter experts, across the globe.

Who Should Attend?

This workshop targets geoscientists and engineers from E&P companies and service providers, as well as academic institutions, dealing with formation evaluation of clastics and carbonate associated with low-resistivity and low-resistivity-contrast pay formations.

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WORKSHOP GUIDELINES

FORMAT
The workshop will be 3 days, consisting of oral presentations, poster presentations and breakout sessions where participants can discuss and investigate a specific theme that is of mutual interest. The first day will feature an inaugural keynote speech by a high-profile professional from the industry.

ATTENDANCE
Registrations are invited from all relevant disciplines with experience and/or knowledge of the subject areas being addressed in the workshop. Registrations will be accepted on a first-come, first-served basis.

CALL FOR POSTERS
You are invited to prepare a poster for presentation at the workshop. If you are interested in participating, please send a short abstract to cnavarro@aapg.org by 6 April 2023. All posters will be produced as pull-up banners and delivered by AAPG. There will not be any other format available for poster display.

REGISTRATION TYPES & FEES
Fees are inclusive of onsite documentation, coffee breaks and luncheons.

$1,850 AAPG Non-Member Fee
$1,850 Join and Save
$1,650 AAPG Member Fee
$1,550 Committee/Presenter
$850 AAPG Young Professional Non-Member Fee
$750 AAPG Young Professional Member Fee
$500 Academia Fee
$350 AAPG Student Non-Member (Masters)
$250 AAPG Student Member (Masters)

*To avail a Member rate you must be an active member of AAPG.
**To register as a Young Professional you must be under the age of 35 with less than 10 years of work experience.

REGISTRATION DEADLINE
To guarantee your seat, please make sure to register by 1 May 2023.

CANCELLATION POLICY
AAPG will refund the tuition, less a $100 processing fee, if the request is received no later than 30 days prior to the workshop. Cancellations must be made in writing. The registrar will accept cancellation notices by telephone, but all such notices must be followed up by fax or e-mail. No refund will be made for cancellations received less than 30 days prior to a workshop being given. Nonpayment of tuition does not constitute automatic cancellation. If no cancellation notice is received by 30 days prior to a workshop, participants are liable for full tuition. AAPG reserves the right to cancel a workshop if enrollment is insufficient to ensure proper effectiveness. Substitutions for individuals can be made at any time. A paid enrollment may be transferred one time to a future workshop if the request is received prior to the 30-day cut-off date.

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SESSIONS DESCRIPTIONS

DAY 1: MONDAY, 8 MAY 2023

SESSION 1: CAUSES OF LOW RESISTIVITY PAY [LRP]/ LOW RESISTIVITY CONTRAST PAY [LRCP] IN CLASTIC RESERVOIRS

Low resistivity pay and low contrast pay have been long standing challenge in petrophysical evaluation for decades resulting in overlooking oil and gas opportunities due to low computed hydrocarbon saturation and consequently underestimating the reserves and/ or bypassing pay zones.

The sources of low resistivity pay in clastics are classified mainly into three main reasons. First reason is related to microporosity in fine-grained (silty) sands, leading to actual high water saturation, but it is irreducible and hence water free hydrocarbon is produced. The second reason is underestimating of actual hydrocarbon saturation caused by presence of conductive minerals such as clay minerals and iron minerals particularly pyrite. The third reason is finely laminated sand/shale sequences, in which the thickness of the individual layers is much smaller than the vertical resolution of the resistivity tools.

Clay minerals are conductive due to their high cation exchange capacity (CEC) value. The clay with higher CEC has the more impact on lowering the resistivity reading. Clay can be distributed in the clastic rocks in four different ways: laminated, structural, dispersed and any combination of these style.

Low contrast pay occurs mainly when formation waters are fresh or low salinity, as a result, resistivity values are not necessarily low but there is little resistivity contrast between oil and water zones.

SESSION 2: CAUSES OF LOW RESISTIVITY PAY [LRP]/LOW RESISTIVITY CONTRAST PAY [LRCP] IN CARBONATES

In recent years, in most parts of the world, the conventional reservoirs are already "creamed", where the best prospects have been already explored and involved into production. While the remaining potential of conventional plays is limited, the oil companies face the challenge of exploring more complex reservoirs that have been overlooked before or that were not considered economic to develop. These include the low resistivity and low resistivity contrast pays.

In most cases, Petrophysicists associate the concept of Low resistivity pay with laminated sand-shale sequences, but these challenges are not limited to these types of rocks.

The role of complex carbonates is becoming increasingly important. Economic rates from the intervals with hydrocarbon saturation less than 0.40 v/v are not uncommon. In some cases, the low resistivity observed in hydrocarbon bearing intervals of such reservoirs is associated with a combination of microporosity/high residual water saturation and high salinity/low formation water resistivity.

Another challenge is represented by reservoirs where there is no clear resistivity contrast and saturation between water legs and hydrocarbon-bearing intervals despite saturation in both cases can be quite high. The reasons can vary from the trivial effect of deep mud filtrate invasion to the complex rock structure, for example unconnected mouldic or vuggy porosity. Complex mineralogy, the presence of conductive minerals, residual hydrocarbons and bitumen can also complicate the petrophysical interpretation.

DAY 2: TUESDAY, 9 MAY 2023

SESSION 3: EVALUATION METHODS IN CLASTIC RESERVOIRS

The word "complex" in the clastic world system fits in many dimensions. A whole different system can be examined, with wide range of scales, when looking under the microscope or to an outcrop. It might sound simple to some when dealing with three components, sand, shale and pore media; however, nature has been continuously demonstrating challenging situations whenever the otherwise is presumed. This preludes into how a complex system can be evaluated and deciphered.

Advances in science is accelerating year by year for the last century and professionals are employing these advances with a cutting-edge technology to have a better understanding of the natural behaviors of rocks. There are almost unlimited combinations of mixtures of sand with shales, other minerals and/or porosity architecture. Then, it is our task to identify these combinations as it requires our skilled professionals to spot the challenges associated with it.
We mostly rely on our tool's responses, experiments and understanding of the geological description to spot low resistivity or low contrast pay, which exhibits in many cases unique challenges. We always strive towards finding solutions to accurately characterize, evaluate and understand our matrix and porous systems.

SESSION 4: EVALUATION METHODS IN CARBONATE RESERVOIRS

Accurate quantification of fluids and their distribution in low resistivity and transition zone carbonates often poses a challenge to the interpreter. The heterogeneous pore structure systems of carbonate formations can be complex and challenging to evaluate. Dry oil production from low resistivity intervals, mixed flow production, or disparity between formation evaluation analyses and surface tests can lead to lower confidence in the downhole measurements or interpretation and increase the uncertainty of the calculated hydrocarbon volume in place.

If the oilfield is to be developed, it may take a long production time to validate the constituents, measurements or assumptions of the Petrophysical model. Nevertheless, a variety of measurements and interpretation techniques may be exploited to mitigate these concerns.

Geoscientist working with such challenges, needs to have versatile skills and ability to efficiently integrate and interpret data from measurements acquired at different scales. Understanding the pros and cons of each methodology is a critical part of integrated data analysis. The pore-scale imaging and other DRP methods can assist in understanding the very localized pore systems. At the same time, may mislead the practitioner if samples are not covering all textures within the studied formation.

Fit for purpose SCAL analyses may reveal critical insights; however, the results need to be carefully evaluated and processed in order to be used in Petrophysical model. The Wireline and LWD survey are of lower resolution; however, are essential, and in addition to direct volumetric interpretation, can be used to establish a link (continuous logs) between the insights from point DRP/SCAL measurements and fluids distribution. The well logs analysis in LRP reservoirs may bring the misleading results when using conventional saturation equation. Considering the heterogeneity of carbonates textures, various tools and technology have been proposed to address the challenge of saturation evaluation in LRP/LRCP in carbonate reservoirs.
These range from better definition of the Archie paraments through the use of Resistivity Independent Saturation Evaluation has been proposed through the use of dielectric, NMR, and pulsed neutron logging.

All in all, the evaluation of LRP/LRCP carbonates requires good understanding of the reservoir and high quality fit-for-purpose measurements

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DAY 3: WEDNESDAY, 10 MAY 2023

SESSION 5: CORE ANALYSIS ROLE AND APPROACHES IN IDENTIFYING, SOLVING LRP/ LRCP

Low resistivity (LR) and low contrast (LC) resistivity pay reservoirs pose a major challenge to the industry when attempting to measure their conductivity versus different saturation units and capillarity. This can be rooted to the difficulty in recognizing their presence and quantifying their unlocked hydrocarbon potential.

Laboratory core analysis (SCAL) techniques measures Electrical parameters (a, m and n) as a function of different fluid saturations. These experiments provide the necessary inputs to refine water saturation calculation from electric logs and the accuracy of reserves estimation are improved.
With excess conductivity experiments, effects of clay conductivity can be quantified. This allows us to correct the measured electrical parameters into m* and n*. These new parameters will improve reserves estimation.
Capillary pressure experiments, such as Mercury Injection Capillary pressure (MICP), provides additional understanding of porosity partitioning within the pore system. In addition, capillary pressure resistivity index (PcRI) experiments provides additional valuable information but is time extensive. Integrating the above information with petrography, XRD and SEM allows us to better understand porosity types; mineralogy, clay types, content and distribution and how they impact the acquired resistivity data.

Though resistivity experiments can be time consuming and challenging in an environment where quick solution is required however if project is designed to objectively provide the desired results in an acceptable timeframe; the value of electrical measurements cannot be underestimated.
New techniques are on the increase and could provide new directions to identify, understand and resolve LRP/LRCP cases.

The challenge of describing and quantifying low resistivity and/or low contrast pay realistically depends on core availability, the quality of the core samples and sample representativeness. On top of that, sample size (i.e cuttings, plugs or while core) is another major factor to capture full heterogeneity since LRP/LRCP systems can depends heavily on them.

This session will focus on building the understanding LRP/LRCP, current core analysis techniques and how we can leverage on new technology to provide new direction to identify new analytical techniques or modify current workflows.

Core Analysis measurements are the only "ground truth" that provide direct measurements on core samples hence it will continue to play a pivotal role in providing the necessary inputs to models for log interpretation.

SESSION 6: DIGITAL ROCKS: NEW DATA AND METHODS

In the last years, the energy industry has been clearly taking advantage from novel, automatic approaches to data management, data analysis and data interpretation, in every aspect of its business: the "digital wave" is quickly changing the way we look at our assets.

Machine learning techniques provide the capability to process big amounts of heterogeneous data and to build data-driven models from examples; image processing techniques allow a quick and automatic analysis of many different geological images, including image logs, photographs of thin sections and core tomography images. Together, they not only give robust and objective answers, but also contribute to maximize the value of company's data and to cut down interpretation time.

Such novel approaches could benefit from the integration of conventional and high-profile measurements, in synergy with data-driven interpretation processes, to provide more realistic reservoir models, calibrated to the specific geologic framework under investigation and by exploiting valuable information derived from analogues and by honouring production history. For instance, Bayesian Methods and Ensemble Modelling could provide intrinsic estimates of the uncertainty associated to the predicted properties.

In addition, fit-for-purpose image processing techniques could add significant insight to our knowledge of the reservoir fabric, thus allowing more robust estimates of the prospective productivity of each specific reservoir facies.

The aim of this session is to discuss the application of new digital technologies to the description and evaluation of low resistivity pays and its benefits, either in the assessment of the potentiality of new fields or in the revamping of mature assets and by-passed pays.