Workshop Outline
A technical workshop is scheduled for sharing knowledge, experience and formation evaluation pertaining to low-resistivity and low-resistivity-contrast pay. Challenges in identifying and evaluating low-resistivity and low-resistivity-contrast pay with conventional log analysis have been acknowledged over the last four decades in the oil industry. Historically, there are many field cases where the low-resistivity pays was overlooked and subsequently discovered to be potential pays. The legacy saturation cut-offs often lead low-resistivity and low-resistivity-contrast pays to go undetected. We do not know exactly how many low-resistivity and low-resistivity-contrast pays were abandoned over the years, because of failures to recognize their potential as commercial pays. The concept of causes for low-resistivity and low-resistivity-contrast pay have been enriched over the years. The advancements in logging tools & technology, along with the innovations that have been taken place in science & technology, and formation evaluation algorithms to deal with the complexity, have evolved over the last three decades. Consequently, more and more low-resistivity pay case studies are coming into the limelight world-wide. This workshop is essentially an attempt to bring the global talent to the table to exchange expertise gained over the years from fields located in different regions and divergent geological setups, on manifestation and causes of low-resistivity and low-resistivity-contrast pay locally and also experience in dealing with the complexity of the formation evaluation through new tool technology and algorithms. The workshop will help participants improve their skills to recognize low-resistivity and low-resistivity-contrast pay in the early life of a field and evaluate its commercial potential.

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 pay formation from the exposure to regional and global case studies and the state-of-the-art technologies being employed as part of the evaluation. The forum will facilitate to make a network with subject matter experts, across the globe.

Who Should Attend?
This workshop targets petrophysicists and geologists, from E & P companies and service providers, as well as academic institutions, dealing with formation evaluation of clastics, in general, and shaly and silty sandstone reservoirs in particular, associated with low-resistivity and low-resistivity-contrast pay formations.

Session Topics
- Causes/Manifestations of Low Resistivity Pay
- Causes/Manifestations of Low Resistivity Contrast Pay
- Tools / Latest Technologies to Detect Low Resistivity Pay
- Evaluation / Technical Approaches and Workflow of Low Resistivity Pay
- Core Analysis Role / Approaches in Identifying, Solving Low Resistivity Pay
CAUSES/MANIFESTATIONS OF LOW RESISTIVITY PAY (LRP)

Low resistivity pays (LRP) have been recognized as a challenge in saturation evaluation (using resistivity) worldwide over the years of exploration and studies. Low Resistivity (LR) originates from several causes, and therefore, understanding those is of crucial importance. The causes leading to LRP can be classified broadly into two main groups: 1) arising from micro-porosity and 2) conductive minerals. Micro-porosity dominant reservoir pays, associated with fine grains holding more irreducible water (high Swir) due to increased surface area, is manifested as low resistivity on data, while it can still produce dry oil. The second group of LRP comprises of the pays with low resistivity arising from clay minerals and conductive minerals, such as pyrite, glauconitic, hematite or graphite.

Throughout the world, clays are the primary cause for LR and the extent of low resistivity essentially depends on type, amount and the morphology of the clay minerals. The clays have excess conductivity expressed as Cation Exchange Capacity (CEC); and their content in the rock lowers the resistivity.

Although LRP can occur in both sandstone and carbonate reservoirs, it is more common in sandstones. Hydrocarbon-bearing carbonates, with strongly bimodal porosity distribution of intra-granular micro-porosity and inter-granular macro-porosity, have also been reported in case studies, to be possessing very low-resistivity.

Certain depositional setups; such as low-stand basin floor fan complexes, deep water lavee-channel and over-bank deposits, transgressive-marine sands and lower parts of delta front deposits and laminated silt-shale-sand intervals in the upper parts of alluvial and distributary channels, lead to origination of LRP. The conductive clays can be formed during deposition or diagenesis. Carbonate reservoirs can be highly heterogeneous due to the superposition of depositional and diagenetic history.

SESSION 2:
CAUSES/MANIFESTATIONS OF LOW RESISTIVITY CONTRAST PAY

Fresh water (low salinity)-bearing formations can make hydrocarbon-bearings sections indistinguishable from the water-bearing zones. The low salinity of the formation water takes the pay out of the operating range of the conventional empirical shaly-sand saturation models. These circumstances demand new measurements like salinity-independent dielectric constant and the development of suitable empirical relation to evaluate water saturation.

The sessions 1 & 2 will deep-dive into the root causes of LRP/LRCP and their manifestation, their link to depositional environments and implications on P & E industry by presenting case studies from across the world.

DAY 2 TUESDAY 8 OCTOBER

SESSION 3:
TOOLS/LATEST TECHNOLOGIES TO DETECT LOW RESISTIVITY PAY

Various tools and technology have been proposed to address the challenge of saturation evaluation in LRP/LRCP reservoirs. These range from better definition of the mineralogy and clay content through the use of nuclear spectroscopy, improved bed definition and quantification through the use of borehole images, use of NMR for shale and micro-porosity quantification, 3D resistivity logging for estimating true bed-parallel resistivity for better saturation estimates in the reservoir layers. Even Resistivity Independent Saturation Evaluation has been proposed through the use of dielectric, NMR, and pulsed neutron logging.

In this session we would like to hear about existing and upcoming advances in data acquisition promising to address the challenges in LRP/LRCP reservoirs.

SESSION 4:
EVALUATION/TECHNICAL APPROACHES AND WORKFLOW OF LOW RESISTIVITY PAY

The challenge with Low-resistivity and low-resistivity-contrast pays lies essentially with the evaluation of water saturation (Sw) mitigating the risk of overlooking pay or underestimating oil in place. Low Resistivity Pay is caused by “excess” conductivity and cannot be interpreted meaningfully though conventional clean-sand or shaly-sand (dispersed) models. They are not, hence, recognizable through conventional log analysis. Similar problem exists with low-resistivity-contrast pays especially in fresh formation water bearing formations, where the absolute resistivity may not be low, but the resistivity contrast between the hydrocarbon and water legs is small. There is nothing abnormal about the rock. It simply deviates from our assumptions, so that our Sw calculation is too pessimistic.

The low resistivity pay could also partly be due to the geometrical function of the logging tools. The treatment of the problem is, hence, twofold: 1) identifying the cause and 2) treating the data using the algorithm specific to the cause. The first and foremost is identifying the cause of the low-resistivity pay from its manifestation on the field data. The formation evaluation of these pays needs special focus and involves applying specifically developed algorithms through an empirical relation established between the low resistivity and the parameters such as rock texture, pore size/ grain size, clay minerals, morphology of clay minerals, salinity and saturation of formation water. The problem of low resistivity has been recognized for decades and many solutions have evolved over the years to address this.
The solutions reported in the literature are, often, pertinent to a specific reservoir or a field or a region. The generic solution applicable to all the reservoirs and all the causes across the board are still far from the dream. The need to incorporate new measurements, such as multi-directional resistivity measurements, resistivity-independent-responses like NMR, dielectric measurements, Pulsed-Neutron techniques and etc. as well as integrated evaluation with resistivity- and resistivity-independent measurements has been well recognized for more realistic interpretation.

Saturation evaluation techniques for low resistivity carbonates have been attempted regionally, especially by applying variable ‘n’ parameter in Archie equation to account for water filled micro-porosity short circuits.

The scheduled session is intended to share the best practices and approaches that are being employed in the evaluation of low-resistivity and low-resistivity-contrast pay with the global petrophysical community and, in turn, develop the required skills for realizing the locked in potential.

**DAY 3 WEDNESDAY, 9 OCTOBER**

**SESSION 5: CORE ANALYSIS ROLE/APPROACHES IN IDENTIFYING, SOLVING LRP AND THE ROLE OF DIGITAL ROCK ANALYSIS**

This session focuses on building the understanding of specific reasons for LRP followed by constructing new models for log interpretation derived from integrated core analysis. Integrated core analysis applies physical and digital analyses methods to define petrophysical properties that can be used to build new models that relate log measurements and core data to water saturation. Laboratory core analysis techniques measure rock conductivity as a function of different fluid saturations. These experiments typically include MICP (mercury injection capillary pressure) or PcRI (capillary pressure resistivity index). The MICP process is rapid and provides the distribution of pore throats in the system, the foundation for understanding porosity partitioning. The PcRI experiments are difficult to perform and require a long time. The integration of MICP experiments and digital rock analysis may provide a new direction to identify and resolve LRP cases. The challenge of describing and quantifying LRP systems is heavily dependent on the available rocks at the surface: whole cores, sidewall cores, or cuttings.

The intendent session is focused on defining the causes of LRP, what sandstone or carbonate rock samples can be used effectively to solve the LRP puzzle, and what integrated workflows would lead to new LRP water saturation models.
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**REGISTRATION TYPE & FEES**

- Member*/Speaker ($1,500)
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