Enhancing Permeability Prediction In The Field Through Advanced NMR Scanning Technology: Leveraging Conventional Log Data For Improved Results

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Objectives/Scope: Field A is distinguished by two distinct zones: shallow and deep reservoirs, which exhibit different properties. Well A-1 was an exploration well, drilled into the deep reservoirs to determine the presence of hydrocarbons and evaluate their potential, while also obtaining conventional cores for Nuclear Magnetic Resonance (NMR) measurements. The deep reservoir was found to be oil-bearing, but it presents challenges due to low porosity and permeability values. The objective of this study is to develop an AI model that leverages on core NMR measurement results to predict the quantity of moveable fluid, porosity, and permeability of reservoir rocks in un-cored intervals and in other existing wells, using conventional log data as the input. The output will be logs of moveable fluid, porosity, and permeability values, which can be employed to assess the potential and flow capacity of the deep reservoir rocks.

Methods, Procedures, Process: Log data might not be adequate for accurately assessing the potential of low porosity, low permeability reservoirs, as limited resolution and lithology effects can compromise measurement reliability. Given the high risks associated with these challenging reservoir conditions, core NMR analysis has been employed to mitigate complexity and risk by capitalizing on the unique benefits offered by NMR techniques. The Random Forest, a machine learning approach, will be used to examine and establish correlation networks between various log parameters, such as gamma-ray, resistivity, density, and neutron logs, in relation to core NMR results. Multiple wells with diverse, representative, and unbiased NMR data were employed to facilitate the model learning process and enhance the predictive capability for the aforementioned properties.

Results, Observations, Conclusions: The outcomes of this study indicate that the developed AI model can effectively predict the quantity of moveable fluid, porosity, and permeability in cored intervals. The model demonstrates satisfactory to moderate performance under challenging borehole conditions, which affect input log readings, or when there is a minor variation in the depositional environment. It becomes apparent that the AI model's predictive capabilities are heavily dependent on the quality and diversity of input data. Factors such as depth variations, which account for compaction effects, and the presence of different fluids in reservoir sands can lead to imprecise or biased model predictions.

Novel/Additive Information: This study concentrates on a particular area of Field A, employing NMR data from a specific field within a distinct geological environment. To bolster the AI model's predictive capabilities, it is advisable to train the model on data from varied geological settings, mineralogical compositions, and reservoir complexities. Additionally, there is significant potential in utilizing the AI-based model to quantify uncertainties related to rock property predictions. This approach would facilitate more precise risk assessments and informed decision-making, enhancing the efficacy of reservoir management strategies.