Logging Curve Restoration Techniques: Do We Need AI for That?

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Abstract

Logging curve restoration is a crucial process in the oil and gas industry, aimed at reconstructing the original well log data from incomplete or degraded measurements. This abstract highlights the significance of logging curve restoration, provides an overview of restoration techniques, and evaluates the pros and cons of AI-based and theoretical methods.

Restoration of missing logs may enable engineers and geoscientists to take informed decisions regarding drilling, completion, and production strategies, ultimately optimizing hydrocarbon recovery and maximizing economic returns. For example, Sonic restoration can be important for Quantitative Interpretation, time-depth conversions and frac design.

Various restoration techniques exist, including model-based methods, statistical approaches, and machine learning algorithms. Model-based methods utilize mathematical models to estimate missing data points, while statistical approaches infer missing values based on statistical properties of the data. Machine learning algorithms, particularly AI-based methods, leverage large datasets to learn complex patterns and relationships, offering promising solutions for logging curve restoration.

AI-based methods exhibit several advantages, including their ability to handle nonlinear relationships and adapt to diverse data distributions. They can efficiently process vast amounts of data and continuously improve their performance through iterative learning. However, AI-based approaches require substantial data for training and may lack transparency in their decision-making process.

On the other hand, theoretical methods offer interpretability and simplicity, making them easier to implement and understand. They rely on well-established mathematical principles and physical relationships between the parameters but may struggle if the rock model is poorly understood.

In the current abstract, theoretical curve restoration is applied to different reservoirs of the Sultanate Oman. The minimum required dataset for restoration includes Porosity, Volume of shale, prevailing lithology and Stratigraphy. Good restoration is achieved for Density, Photoelectric factor, Neutron, Compressional and Shear Sonic, Poisson’s ratio. Restoration is based on theoretical equations relating porosity, mineralogy, pore geometry and Saturation with log response. The main parameters to adjust are usually shale properties.

One of the additional outcomes of the restoration techniques could be the interpretation model improvement, and the advanced data quality control and corrections based on the response of the logging curves in clean intervals.