

Data Analytics and Machine Learning Application for Reservoir Potential Prediction in Vuggy Carbonate Reservoirs Using Conventional Well Logging

Amr Gharieb, Khalda Petroleum Company, Apache Egypt JV, Cairo, Egypt; Mohamed Adel Gabry, University of Houston, TX, USA; Mohamed Elsayy, Khalda Petroleum Company, Apache Egypt JV, Cairo, Egypt; Ahmed Algarhy, Marietta College, OH, USA; Ahmed Farid Ibrahim, King Fahd University of Petroleum and Minerals, Dhahran, KSA; Nihal Darraj, Department of Earth Science and Engineering, Imperial College London, UK; M. R. Sarker, Marietta College, OH, USA; Samuel Adel, Khalda Petroleum Company, Apache Egypt JV, Cairo, Egypt

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Abstract

The objective of this study is to tackle the challenges associated with assessing the potential of carbonate reservoirs, especially when specialized logs such as image logs are unavailable. The primary aim is to introduce a novel workflow that integrates machine learning and data analytics to improve the evaluation of carbonate reservoir potential using conventional logs.

The recommended technique has several aspects. Beginning with feature engineering, techniques such as geometric and harmonic averaging, combined with Z-score standard deviation, are applied to log data. This process yields a diverse set of over 200 metrics, offering a panoramic view of the reservoir's nature. Following this, Principal Component Analysis (PCA) is employed as a means of dimensionality reduction. This strategic implementation of PCA becomes instrumental in honing in on the pivotal variables paramount for an accurate reservoir evaluation. Complementing these methods, data visualization, particularly through strategic parameter plotting, assumes a pivotal role. It aids in distinguishing inherent relationships, and patterns, and offers insights critical for an informed reservoir assessment.

Out of the diverse outcomes, two observations distinctly stand out. First, through the lens of advanced visualization techniques, there emerges a discernible boundary separating the high-risk from the low-risk reservoir zones. This critical delineation provides a cornerstone, bolstering decision-making with amplified confidence. Second, a machine learning model, crafted leveraging the engineered features, comes to the fore, showcasing an impressive accuracy rate that surpasses 85%. What makes this accomplishment particularly remarkable is that such precision was attained by relying solely on conventional logs, eliminating the customary dependency on specialized tools.

In summation, this study makes an emphatic case for the integration of advanced data science techniques in carbonate reservoir evaluation, especially when confronted with the absence of specialized logs. By offering a comprehensive methodology buoyed by machine learning, the research not only charts a methodological path forward but also presents the industry with a cost-effective reservoir assessment paradigm.