Book of abstracts
XXIII Conference of PhD Students and Young Scientists
June 13 – 15, 2023, hybrid event

A case study of petrophysical prediction using machine learning integrated with interval inversion in a tight sand reservoir in Egypt

M. M. G. Abdelrahman *[1], N. P. Szabó[2],

[1] *Department of Geophysics, University of Miskolc, 3515 Miskolc-Egyetemváros, Hungary*

[2] *Geoengineering Research Group, MTA-ME, University of Miskolc, 3515 Miskolc-Egyetemváros, Hungary*

*Corresponding author: mh.geophysicist@sci.asu.edu.eg

Keywords: Robust cluster technique, Borehole logging interpretation, Inverse problem, Petrophysical prediction

Machine learning and artificial intelligence have become popular due to their ability to analyze massive amounts of data and make precise predictions in various industries. With the increasing availability of data, these technologies are expected to continue playing a significant role in shaping our world. This study discusses a new algorithm for reservoir characterization using borehole logging data. The proposed algorithm integrates unsupervised machine learning techniques and interval inversion to determine the layers' boundaries, zone parameters, and petrophysical parameters automatically. The research aims to reduce the time and manual input required for borehole inversion to estimate petrophysical parameters. The integration of the new cluster technique and interval inversion can also enhance the automatic detection of both the geometrical and petrophysical parameters. The study evaluates the suggested algorithm using synthetic and field data and demonstrates its effectiveness in distinguishing between various forms and providing a preliminary estimate for layer thicknesses. The algorithm was used to predict the shale parameters such as cementation exponent, density of shale , and neutron of shale. Field well logging measurements were obtained from an oil and gas field situated in the northeastern region of Egypt. Based on the geological characteristics of the area, the main reservoir being sought after is the Jurassic reservoir. This particular reservoir is composed of a dense sandstone layer that exhibits a significant level of heterogeneity due to diagenesis, which is the process responsible for converting kaolinite into illite. The algorithm has been used for predicting the cementaion exponent as well as the petrophysical parameters. This transformation leads to a decrease in both porosity and permeability. The data collected from this well includes gamma-ray, neutron, density, shallow resistivity, and deep resistivity logs. The field data reveals that the reservoir is made up of sandstone that varies in quality, impacting both the storage capacity and the saturation of hydrocarbons. The two algorithms demonstrate consistent convergence of the distance of the data at 7.5%.

To sum up, The integration between the new cluster technique and the interval inversion can help with the automatic detection of both the geometrical and petrophysical parameters, thus improving the time-intensive and laborious process of borehole inversion to estimate petrophysical parameters.

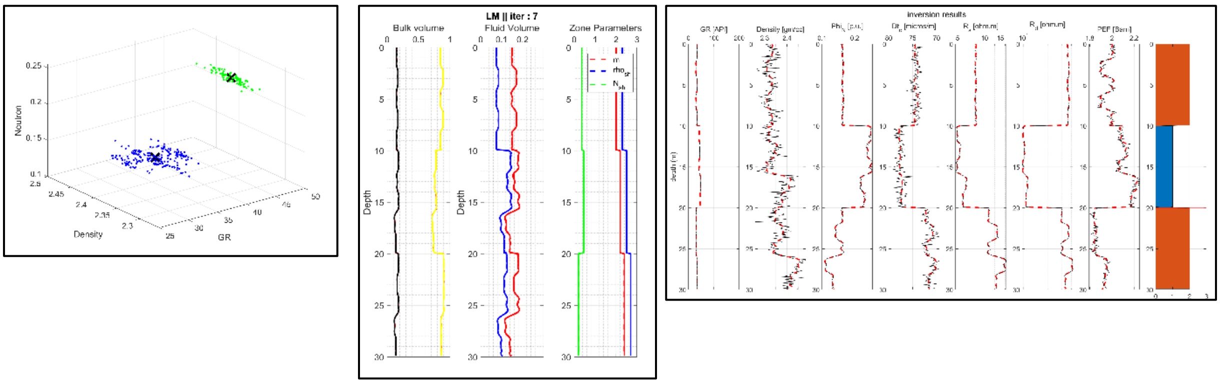

Figure 1. Automatic detection of the layers' boundaries and reservoir parameters.