

## Porosity estimation of carbonate reservoirs using hybrid deep neural network model based on well data

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(Received: 02 June 2024, Accepted: 26 August 2024)

### Abstract

Estimating porosity in carbonate reservoirs is challenging and complex due to the intricate pore systems and heterogeneity. Porosity represents the fluid storage capacity of the reservoir and is crucial for estimating reserves and production capacity; therefore, accurate and precise estimation of reservoir rock porosity is essential. Traditional methods for measuring porosity, such as core analysis and well logging, are often expensive and time-consuming. Deep learning methods and algorithms, by extracting complex patterns from large datasets and analyzing well data, can provide more accurate porosity estimations. In this study, a novel approach using a hybrid deep neural network model is presented for porosity estimation based on well data. The data were collected from a carbonate reservoir in southwestern Iran and include data from core analysis and well logs (gamma, neutron, density, sonic, and resistivity logs). The dataset comprises 2,000 data points, with 236 cores and two wells, divided into training, validation, and testing sets in the proportions of 70%, 15%, and 15%, respectively, for the first well, while the second well was used to evaluate the model's performance. The approach of this study includes data collection and preparation, the design of the hybrid neural network architecture, training, optimization, and model evaluation. Core data were used to validate the constructed hybrid deep neural network model. The coefficient of determination ( $R^2$ ) for the hybrid deep neural network model was 0.98, indicating that this model has a very high accuracy in predicting porosity. A comparison of porosity predictions made by the hybrid deep learning model shows that its performance is more accurate than that of the multilayer perceptron model.

**Keywords:** Porosity, Carbonate reservoirs, Deep learning, Hybrid model, Well data