

ARTIFICIAL INTELLIGENCE ANALYSIS OF POST-STACK CARBONATE RESERVOIR IN SAUDI ARABIA: RESERVOIR CLASSIFICATION AND POROSITY ESTIMATION

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ABSTRACT

One of the objectives in reservoir characterization is to quantitatively or semi-quantitatively map the spatial distribution of its heterogeneity properties. With the availability of 3D seismic data, the artificial neural networks are capable of discovering the nonlinear relationship between seismic attributes and reservoir parameters. For a target carbonate reservoir, this paper adopt a two-stage approach to conduct characterization.

First, an unsupervised neural network, the self-organizing map (SOM) method, is implemented to classify the reservoir quality (an indicator to lithofacies). SOM with non-supervised learning performs a feature projection nonlinearly from the high-dimensional (input) space into a low-dimensional (output) feature space consisting of 2D array of neurons in an orderly fashion.

Then, a supervised neural network is used to quantitatively predict porosity of the carbonate reservoir. The wells porosity values are first compared to the network estimation then the network minimizes the error function in an iterative process based on a gradient-descent technique to minimize the difference for an improved estimation of the porosity.

The main input to the neural networks is a 3D seismic cube which covers an area of approximately $4 \times 74 \text{ km}^2$. We use 2976 inlines (in the West-to-East direction) and 1668 crosslines (in the South-to-North direction) from the data cube, with line interval of 100 m in each direction. Four main seismic attributes were used as input to the neural network. The study focus was on the time window covering the reservoir, with a sample rate of 2 ms. The study area covers seven wells. The reservoir is a carbonate reservoir which has formed as a result of a major transgression process that coincided with a rifting along the Zagros; it took place in late Permian age. The reservoir is part of a cyclic carbonate-evaporites of shallow water environment deposition and considered as one of the main non-associated gas reserves in the area.

Keywords: Carbonate reservoirs, reservoir characterization, lithofacies clustering, porosity estimation, self-organizing map, gradient-descent.