

Predicting Lithofacies Using Artificial Neural Network and Log-Core Correlations

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Summary

The production performance of a reservoir largely depends on how best we characterize our reservoir. Lithofacies identification is an integral part of reservoir characterization. Several techniques and methods are available for lithofacies prediction. Artificial neural network (ANN) has gained popularity in recent times and is being used widely these days for prediction purposes. Once the ANN model is made for lithofacies prediction using core-log correlation, we can predict lithofacies in uncored wells/sections.

Introduction

Prediction and performance of a reservoir is largely influenced by the degree of heterogeneity present in the reservoir and reservoirs are intrinsically heterogeneous, especially carbonate reservoirs. Accurate reservoir characterization is needed for a realistic prediction of production performance of a reservoir. Lithology, texture, sorting and diagenetic effects are largely responsible for reservoir heterogeneity. Distribution and identification of lithofacies is essential as they provide qualitative information about reservoir. Every single reservoir has several lithofacies and each lithofacy has its own porosity-permeability relationship (Stan & Pedro). Reservoir characterization by conventional methods like manually making core to log lithofacies correlation on a well to well basis and then making model require lot of efforts and time. New techniques and methodologies are available, which are much faster and efficient. Artificial neural network and Fuzzy logic are some of the new techniques being used broadly in the prediction of lithofacies and permeability in uncored wells.

Approach

Fuzzy logic can be described as the modification of Boolean logic, which is based on ones and zeroes. Fuzzy logic (Nancy & Reinaldo, 2003) deals with grey areas or partial truths where as Artificial neural networks are biologically inspired computational models which emulate human brain in structure, mechanism and functions (Punnee, Hui-Chuan & Bruce, 2001). They are non-parametric and do not make use of pre-defined relationship. When neural nets are trained, they develop an estimation function learned through the experience during training. So, in a sense they

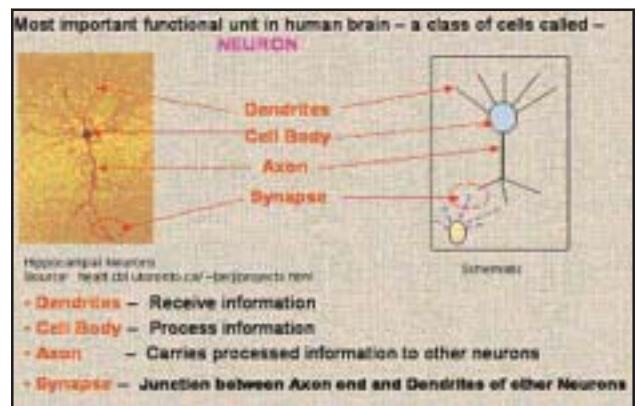


Fig. 1: ANN Architecture

are model free. They can capture subtle relationship among inputs and deal better with noisy data than other prediction methods. Therefore their use in heterogeneous reservoir is profound and valuable.

Artificial neural network structure is shown in fig-1. The structure is based on neuron. Neuron is a module of computation, takes input from dendrites, performs some computation on the input and then produces output along the axon. There are two types of training algorithms-supervised (desired output is known) and unsupervised (output comes about somehow).

In the present study, use of Back Propagation-Artificial Neural Network (BP-ANN), a feed forward network, which is quite popular, was invoked. The term back propagation refers to the training method. In the beginning of the training, the weights are assigned randomly, neurons or nodes process the input layer data and the outcome is fed forward to hidden layer. Again, neurons do the



processing job and the result is transferred to output layer. In the output layer, the output results are compared with the desired output and if there is difference between the two values, the error is fed back by adjusting the weights. The process is carried out till the error is acceptably small or similar input produce similar results. Figure-2 shows the three layered back propagation neural network model used for the study.

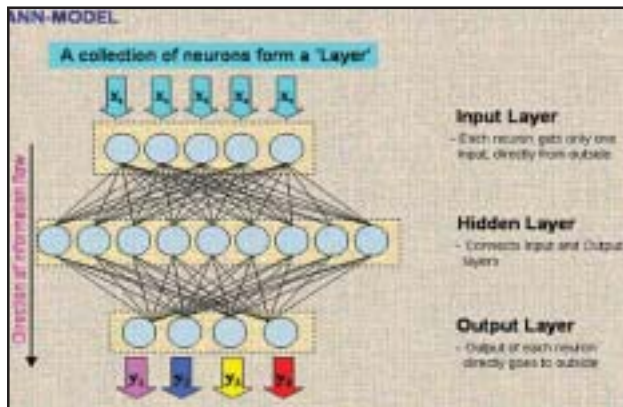


Fig. 2: ANN model used for the study

Reservoir Characterization and Monitoring

Example

The core description data and digital log variables of Well # A were considered for the study. The well is drilled in the Bombay High North field, located on the western offshore area of India. The well was cored in the L-II reservoir. The reservoir is carbonate and complex in nature. Two conventional cores were cut in the interval 947 to 965 mts. & the core recoveries were good (93% & 90% respectively). The core description shows the presence of four main lithofacies. These are shale, Mudstone, Packstone and Crystalline carbonate. The input layer of the model contains five nodes of Shale, Neutron porosity, Bulk density, Gamma ray and permeability. The hidden layer has nine nodes and output layer four nodes representing four categories of lithofacies. Figure-3 shows the actual lithofacies compared to predicted lithofacies. The lithofacies predicted by the model are reasonably good. The model has also predicted lithofacies in the uncored section of the well. As most oil & gas production wells are either not cored or partially cored through reservoir intervals, the successful prediction of lithofacies by BP-ANN is of considerable value.

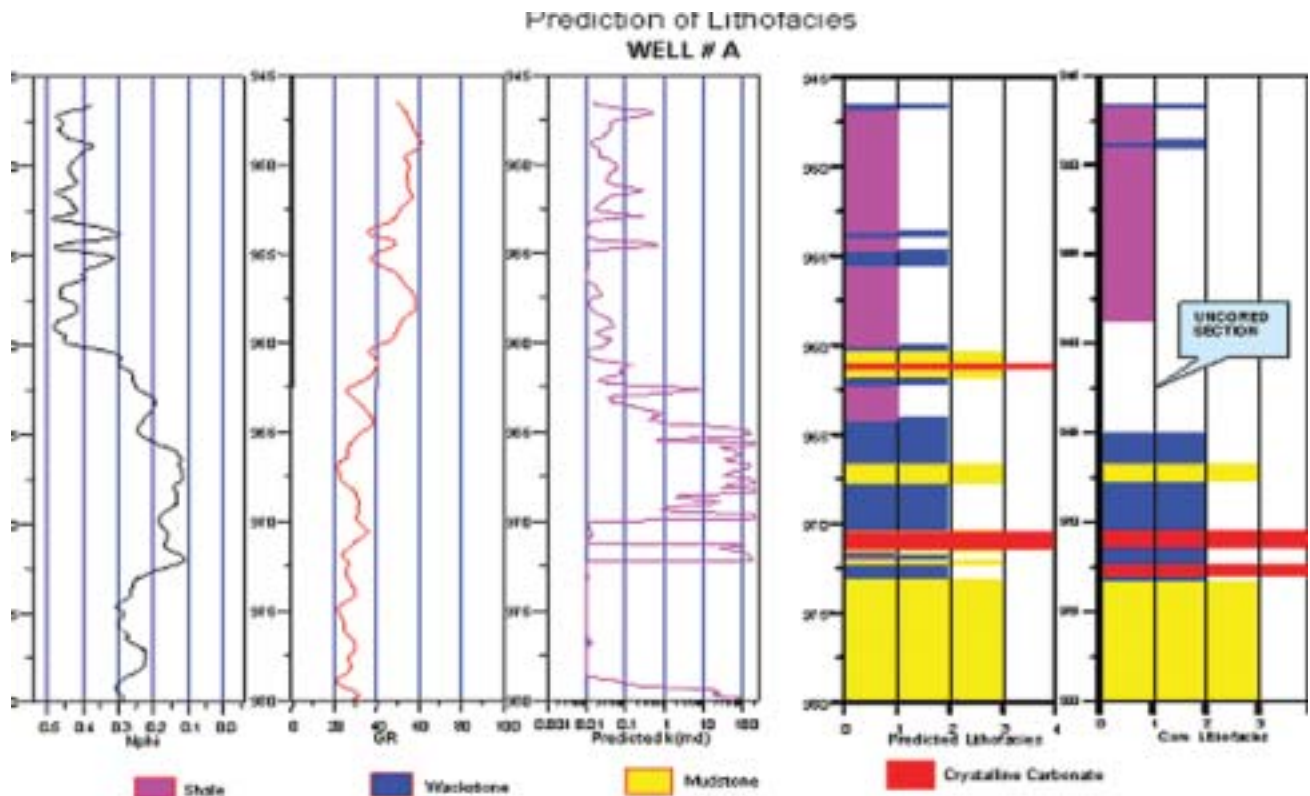


Fig. 3: Predicted v/s core lithofacies

Conclusions

Lithofacies identification and classification is an important aspect of reservoir characterization study. In the present study attempt has been made to integrate core and well log data to identify and classify lithofacies.

This objective has been achieved by invoking the application of Back Propagation –Artificial Neural Networks (BP-ANN) algorithm

Such lithofacies characterization is envisaged to be utilized in development of more accurate correlation between permeability and well log data.

Artificial neural networks have shown great potential where inter-relationship between different variables is too complex.

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References

- Punnee Siripitayanon, Hui-Chuan Chen, Department of computer Science, The University of Alabama. Bruce S. Hart, Department of Earth and Planetary Science, McGill University, (2001), A new technique for lithofacies prediction: Back- propagation neural network. Association for Computing Machinery, Inc.
- Stan Patniyot and Pedro A. Romero, (PDVSA-INTEVEP), Application of core-log correlation and artificial neural networks to better define permeability, porosity and lithology.-
- Nancy Hambalek, PDVSA, and Reinaldo Gonzalez, (2003) Fuzzy logic applied to lithofacies and permeability forecasting. - SPE-81078.