Neural Network and Logical Fuzzy application in Brazilian Carbonate formations using conventional well logging and core data for permeability prediction.

Natalino, C.; De Almeida, H. & Carrasco, A. UFF/TEQ – Niteroi, /RJ

Abstract

Petrophysical information as permeability and porosity are of great importance for reserves evaluation. Rock petrophysics measurements involves some degree of uncertainties especially when carbonates formations are present, because they are characterized for their variation in porosity systems, such as intercrystalline, intergrain, moldic, vuggy and fracture. In this work we compare the results obtained from the applications of neural network and fuzzy logic using conventional well logging and data core for permeability prediction. After using these both techniques, a statistical coefficient called R2 shows better results when using neural networks, being that both of these techniques can be considered efficient tools for uncertainties evaluation.

Although significant progress has happened in modeling problems about porous structure obtained from physical properties of rock, factors as multiplicity of responses, computational stability and availability of core analysis information, limits their reliable petrophysical characterization (Wu & Chen, 2014). The studied field is an heterogeneous carbonate reservoir located in the southwest of Brazil. The lithology of the reservoir is limestone. Permeability in carbonate formations is not only related to porosity, but it also depends on grain size, sorting, pore throat sizes of inter-granular pore space, the amount of unconsolidated vugs (fratures and solution cavities) and the presence or absence of connected vugs, as discussed by Lucia (2004).

The data for this study is composed by a set of openhole logs for an interval of 5580 – 5820 m and a group of 81 permeability core data. The group of input well logging data consists of gamma ray (GR), deep resistivity log (AIT90) showing high values in 5580 – 5750 m, and sonic log (DTCO). Density (RHOZ) and neutron (NPHI) logs are also included, and permeability (mD) data core. Most of core data was taken from the hydrocarbon bearing layer, with most of this information located in the upper part of the log.

For application of fuzzy logic, core data permeability may be classified as excellent, good and poor with respect to the cutoff values. Using fuzzy sets, each value will be a member of each fuzzy set to a membership degree. For permeability prediction, the interval core permeability data and the well logging data was loaded into the IP (Interactive Petrophysics) software. The program first sorts the permeability data in an increasing order and then the other input curves data will be assigned according to their permeability values in each bin. Different bin numbers can be assigned and the result will be dependent on bin numbers. On the other hand, we also applied the neural network technique for these group of data, and the algorithm used was the back propagation neural network, which is probably the most well-known and widely used feedforward neural network system. The term back-propagation refers to the training method by which the connection weights of the network are adjusted. Each interconnection has a numerical value, called weight; and depending on these weights, different input patterns can result in the firing of one or more output neurons. Through training, the output neurons are taught to give the correct answer. The output patter is them compared to the desired output, and an error signal is computed for each output unit.

Considering the results obtained after the application of both techniques, we can note that the use of fuzzy logic and neural networks techniques have proved to be efficient tools for the study of complex data. Comparing these results using the coefficient of determination R2, we have that permeability prediction for this complex formation results in R2 = 0,983 using neural network and R2 = 0,929 when using the fuzzy logic.