ESTIMATION OF ABSOLUTE PERMEABILITY USING ARTIFICIAL NEURAL NETWORKS (MULTILAYER PERCEPTRONS) BASED ON WELL LOGS AND LABORATORY DATA FROM SILURIAN AND ORDOVICIAN DEPOSITS IN SE POLAND

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Introduction

Permeability is a property of rocks which refers to the ability of fluids to flow through each substance. It depends on several factors as pore shape and diameter. Also the presence and type of clay have a large influence on the permeability value (Schön, 2011) Permeability can be measured on rock sample in the laboratory by injecting fluid through the rock under known condition (Tiab & Donaldson, 2000), but this provides only point information. Due to the dependence of the permeability on many factors, the deterministic determination of permeability based on laboratory measurement and well logs is problematic. Many empirical methods for determining permeability are available in the literature and interpretation systems (Asquith & Krygowski, 2004). An interesting approach to the problem is the use of artificial neural networks based on laboratory measurement and modern, high-resolution logging tools.

Samples and methods

Research was carried out on the data from three wells. The data includes basic well logs such as: spectral gamma ray (K, U, Th), bulk density (RHOB), neutron porosity (NPHI), sonic (DT), X-tended Range Micro Imager (XRMI). Laboratory measurements were also used in the analysis. It included density measurement with helium pycnometer, mercury porosimetry (MICP), nuclear magnetic resonance spectroscopy (NMR), permeability measurements using gas permeameter (Węgrzyn et al., 2015). Permeability was also calculated based on logs, using Zawisza and Wyllie-Rose method.

Permeability was estimated with neural network – multilayer perceptron (MLP). MLP networks consist of an input layer, at least one hidden layer and an output layer. Neural networks have the ability to process complex functions (StatSoft, 2011). In this case, the results of absolute permeability from laboratory measurements were used as the output layer and other data as inputs.

Results

Permeability estimated with artificial neural network is better suited to laboratory measurement than permeability calculated with Zawisza model (Figure 1). Coefficient of determination for MLP network is equal 0.72, while for Zawisza model it is only 0.217.

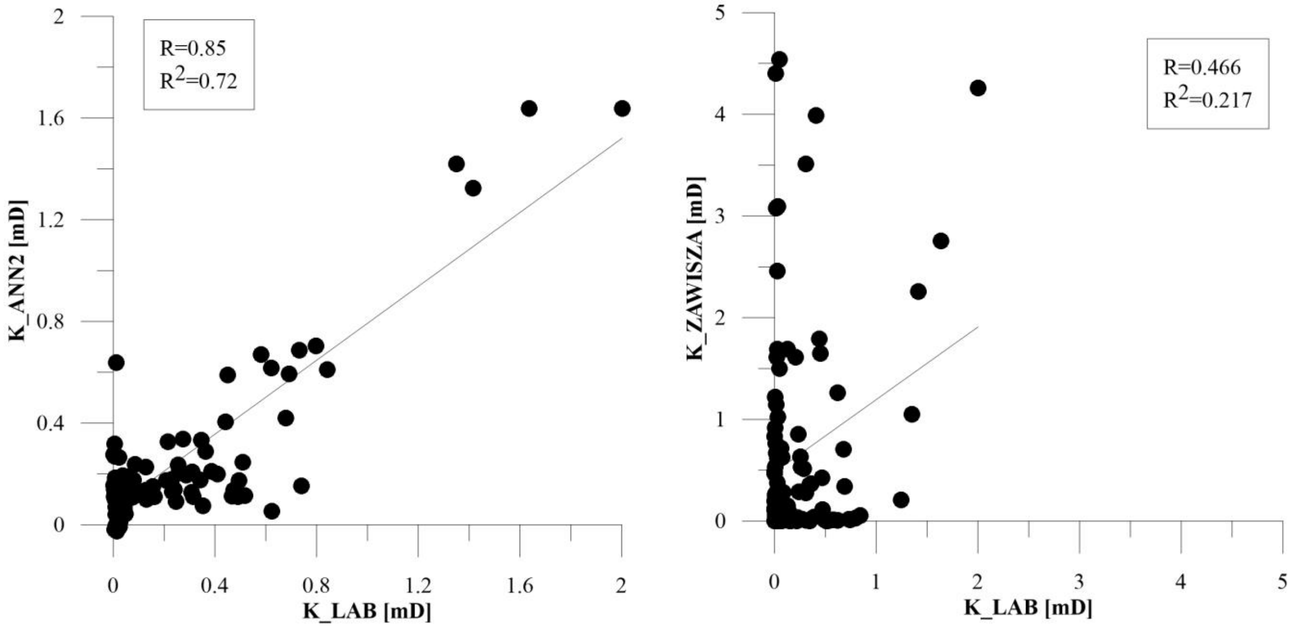

Figure 1. *Regression between absolute permeability estimated with MLP and laboratory measurement (left), absolute permeability calculated with Zawisza model and from laboratory measurement (right).*

Conclusions

Artificial neural networks can be used in petrophysical analysis because they give the possibility to get the information in the form of the log, from larger amount of data and calibrated with the laboratory measurements. Calculations of ANN are fast and quite cheap in comparison to the other measurements and give good results for the parameters with non-linear characteristic.

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