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Total Organic Carbon from well logging in the Silurian and Ordovician shale gas formations in Poland

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Geochemical laboratory analyses are the popular methods providing Total Organic Carbon and other rock properties related to organic matter content. The provided data are point type and related to small rock plugs. The goal of this research was to show usefulness of the advanced statistical methods, i.e. Statistical Neural Networks (SNN) and Support Vector Regression (SVR) in efficient calculation of TOC content on the basis of well logs. The advantage of the proposed solution is the ability to determine the continuous TOC log along the full depth of borehole and the very good matching of TOC values and petrophysical characteristics of the rocks derived from the lab. Results are also free from the geochemical data as Level of Organic Metamorphism (LOM) and no empirical formulae established for the other data sets are included. The disadvantage is a necessity to operate on big data sets which are not a problem for well logging but are expensive for laboratory tests.

Laboratory results and well logging data from the Silurian and Ordovician shale gas formations in the Baltic Syneclise in the northern Poland were used for calculations. Detailed geological and petrophysical analyses showed that the investigated formations varied among others [1, 2] and were different from the literature from known American or other shale gas formations [3]. Therefore the additional goal of this proposed method was the ability to obtain continuous TOC logs free from the equations defined for other formations, such as the Passey et al. formulae based on resistivity and slowness logs [4].

As many log measurements as possible and results of the comprehensive interpretation were used in the ANN analyses and applied in SVR to get optimal results. Also, apparent logs standardized using RMS values defined according to the Liu Yexin group variables [4] were included in the tests. Results of the laboratory TOC values were the ANN output in the learning process. ANN sensibility analysis revealed usefulness of acoustic slowness, DT, and apparent slowness, DTa, as well as apparent bulk density, RHOBa, borehole corrected LLDC resistivity, and spectral gamma ray total intensity, GKUTC, at the first position. That logs can work as efficient TOC indicators. Comparison of the Passey group method and results, and ANN and SVR outcomes with RockEval TOC, showed superiority of the proposed solution.

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