ITERATIVE INVERSION OF DUAL INDUCTION TOOL LOGS FROM THE THIN-BEDDED SANDY-SHALY FORMATION IN THE CARPATHIAN FOREDEEP USING MODIFIED SIMULATED ANNEALING METHOD

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Introduction

In the thin-bedded sandy-shaly Miocene formation in the Carpathian Foredeep the masking effect of high resistivity, which is the result of low vertical resolution of induction tools, is the main source of errors in gas saturation evaluation. The masking effect is especially visible in older boreholes, where the Dual Induction Tool was the primary tool used for determining formation resistivity. This problem occurs because the vertical resolution of logs provided by the Dual Induction Tool is significantly lower than the vertical resolution of logs provided by newer array tools.

Methods

To overcome these limitations an iterative inversion algorithm was applied to resistivity logs recorded by the Dual Induction Tool in the thin-bedded sandy-shaly Miocene formation in the Carpathian Foredeep. The goal of iterative inversion is to minimize the difference between the measured data and the synthetic data generated by the estimated formation model. Our implementation utilizes the vertical response functions of the Dual Induction Tool and modified simulated annealing global optimization method to determine true vertical distribution of measured parameters. The process of selecting model parameters to modification was changed from random selection to weighted random selection. This allows the algorithm to focus on depth intervals where differences between measured data and synthetic data are largest. This results in reduced number of rejected modification of model parameters and reduced computation time.

Results

The algorithm was applied to medium and deep resistivity logs recorded by the Dual Induction Tool in the borehole, where the Dual Induction Tool and the High Resolution Array Induction tool were run in the same depth interval. In addition, repeatability of the results was tested based on 50 independent runs of the algorithm. The results (Fig. 1) show that the algorithm generates resistivity models which provides level of details similar to the High Resolution Induction Array logs with similar depth of investigation and 1 foot vertical resolution. The results of inversion are also highly repeatable.

Conclusions

Proposed method was successfully used to increase the vertical resolution of medium and deep resistivity logs recorded by the Dual Induction Tool in the thin-bedded sandy-shaly Miocene formation in the Carpathian Foredeep.

Acknowledgements

Paper was financially supported from the research subsidy nr 16.16.140.315 at the Faculty of Geology Geophysics and Environmental Protection of the AGH University of Science and Technology, Krakow, Poland, 2019.

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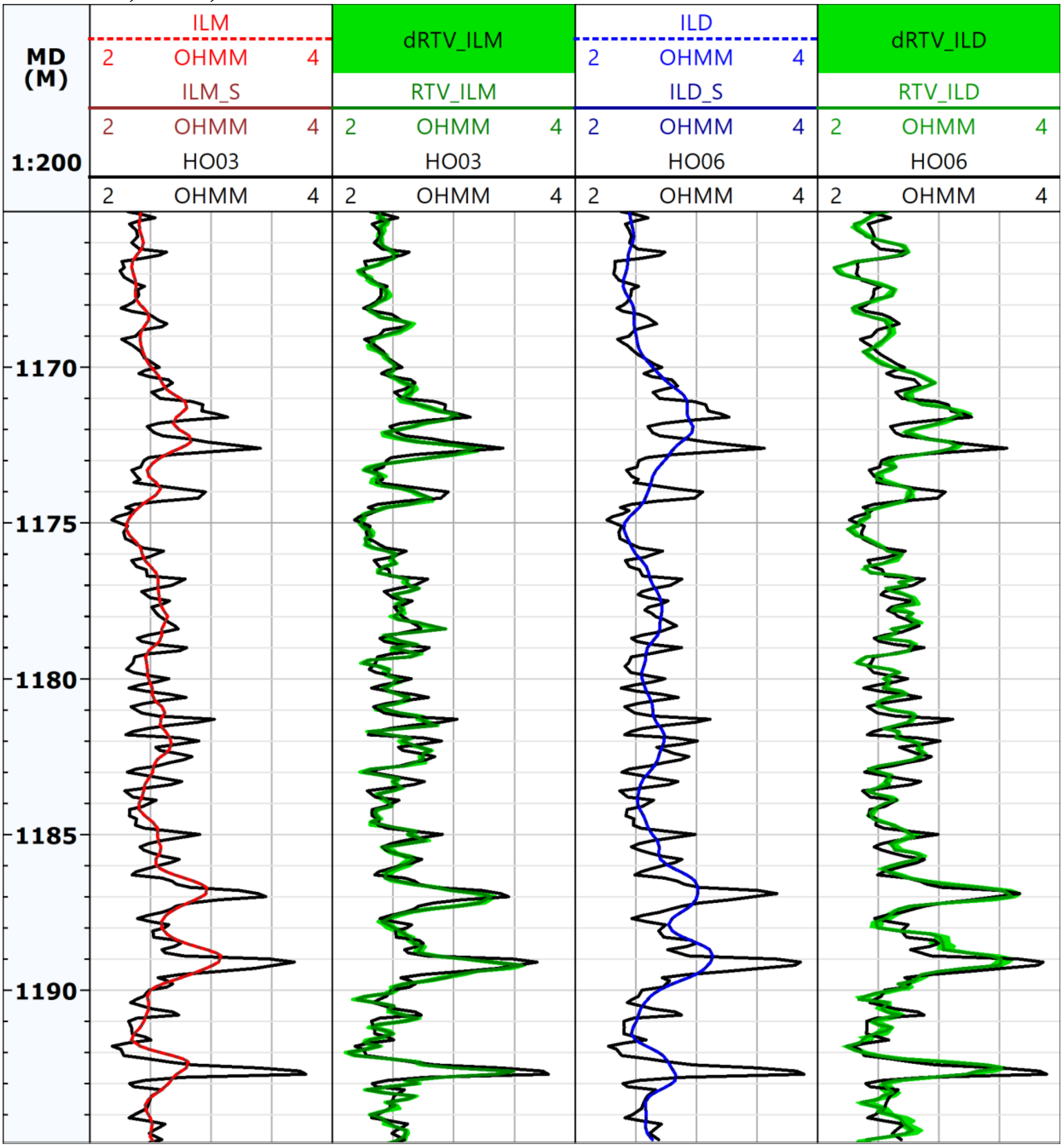

Figure 1. *The results of inversion of the Dual Induction Tool (DIT) logs in comparison to the High Resolution Array Induction (HRAI) logs with similar depth of investigation and 1 foot vertical resolution. ILM - medium DIT log; RTV_ILM – model of true vertical resistivity distribution obtained from ILM log; dRTV_ILM – range of RTV_ILM values obtained during 50 independent runs of the algorithm; ILM_S – synthetic medium DIT log; ILD – deep DIT log; RTV_ILD – model of true vertical resistivity distribution obtained from ILD log; dRTV_ILD – range of RTV_ILD values obtained during 50 independent runs of the algorithm; ILD_S – synthetic deep DIT log; H003 – HRAI log (30-inch depth of investigation and 1 foot vertical resolution); H006 – HRAI log (60-inch depth of investigation and 1 foot vertical resolution).*