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A comparison of the performance of selected optimization algorithms in the process of iterative inversion of normal and lateral resistivity logs

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Abstract

Resistivity logs measured by older generations of logging tools are characterized by significantly lower vertical resolution in comparison to logs measured by newer logging tools which affects the quality of the interpretation. However, the information averaged in the process of logging can be partially restored in the process of iterative inversion. The quality of results obtained from iterative inversion depends on the accuracy of the modelling procedure and the performance of the optimization algorithm. Since the modelling process is usually computationally intensive it is essential to utilize an optimization algorithm that provides good results with as less as possible modelling procedures performed during the inversion process. The poster aims to present a comparison of the performance of several popular local and global optimization algorithms applied to the process of iterative inversion of normal and lateral resistivity logs. The performance of the algorithms is validated on synthetic data to exclude the possible impact of modelling procedure accuracy on the results.

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Test setup and results

Several popular optimization algorithms that utilize different patterns of objective function evaluations within a single iteration of the procedure (Fig. 1) were tested on a simple synthetic formation model (Fig. 2) that consists of a borehole and a sequence of layers of alternating resistivity values without filtration zones. Figure 3 shows the record of the inversion processes of the short-normal log (E16N). The values of the objective functions are plotted against the number of performed iterations, the number of performed objective function evaluations and the number of performed simulation tasks (simulation of a single log value for a single measurement depth). The number of performed simulation tasks is calculated with the assumption that only resistivity values from measurement points located no further than 2 m from layers where values of model parameters were changed since the last function evaluation are affected by the change in a meaningful way and have to be recomputed. In addition, due to long computation times, each algorithm was arbitrarily terminated after 25000 objective function evaluations if the process was not terminated earlier by the algorithm itself.

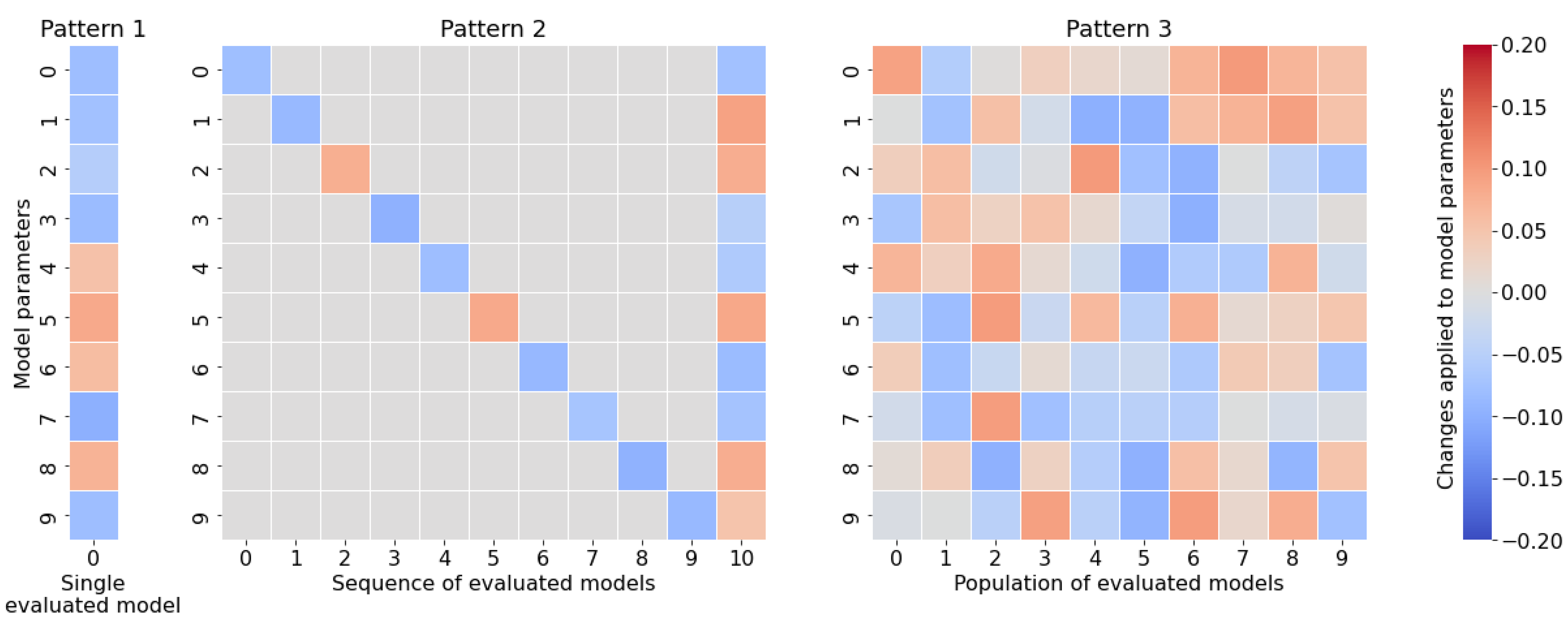

Fig 1. Basic patterns of models that are evaluated by optimization algorithms within a single iteration.

Conclusions

Test results show differences in the performance of tested optimization algorithms both in the area of convergence rate and quality of obtained solution. They also indicate that to correctly evaluate different optimization methods and choose the correct one it is necessary to understand how different algorithms work since the number of performed iterations or performed objective function evaluations is not always directly linked to the amount of the computations that have to be done by the algorithm.

References / Utilized software

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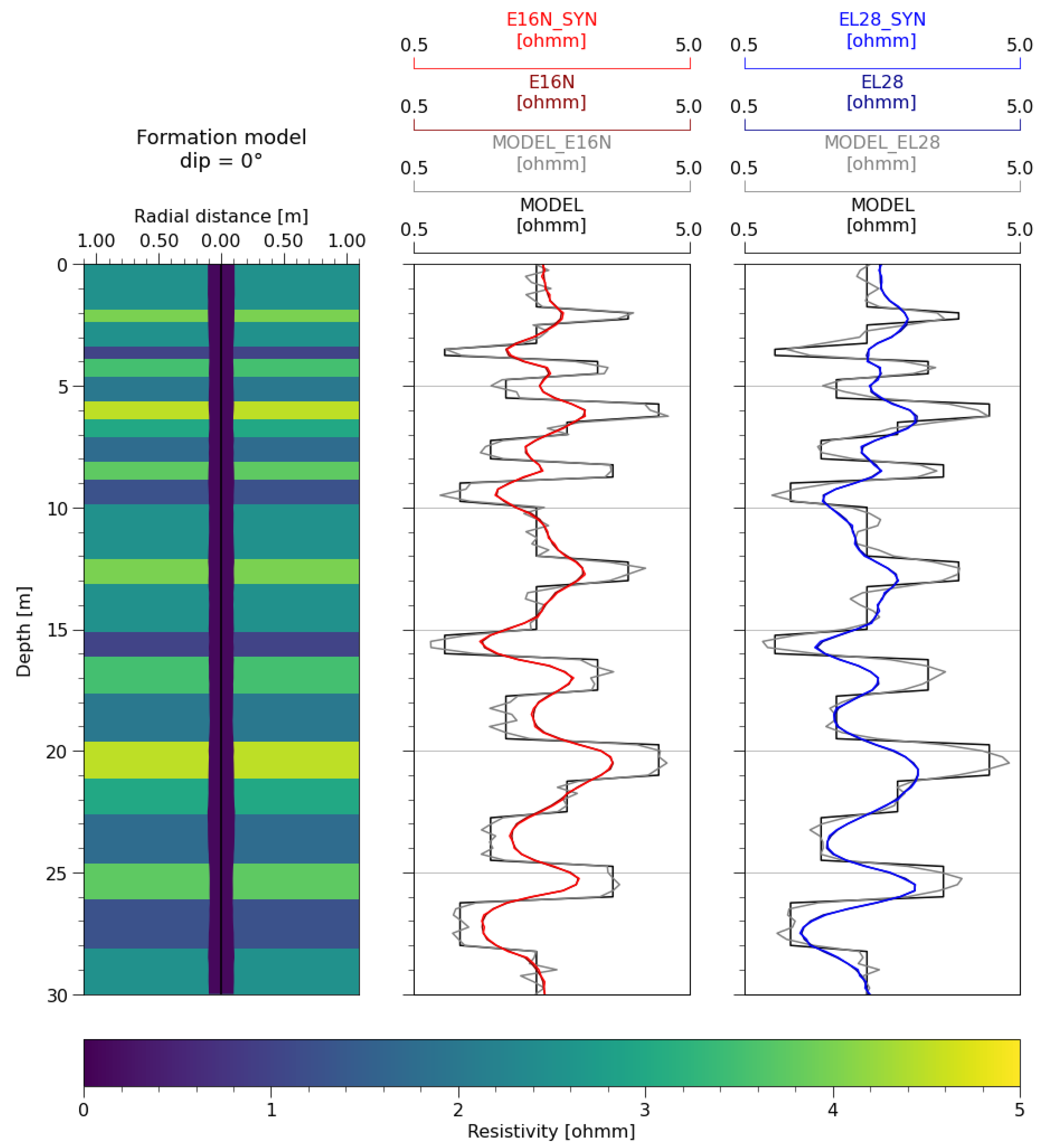

Fig 2. Formation model (left track) with exemplary results of inversion of short-normal log (central track) and long-lateral log (right track).

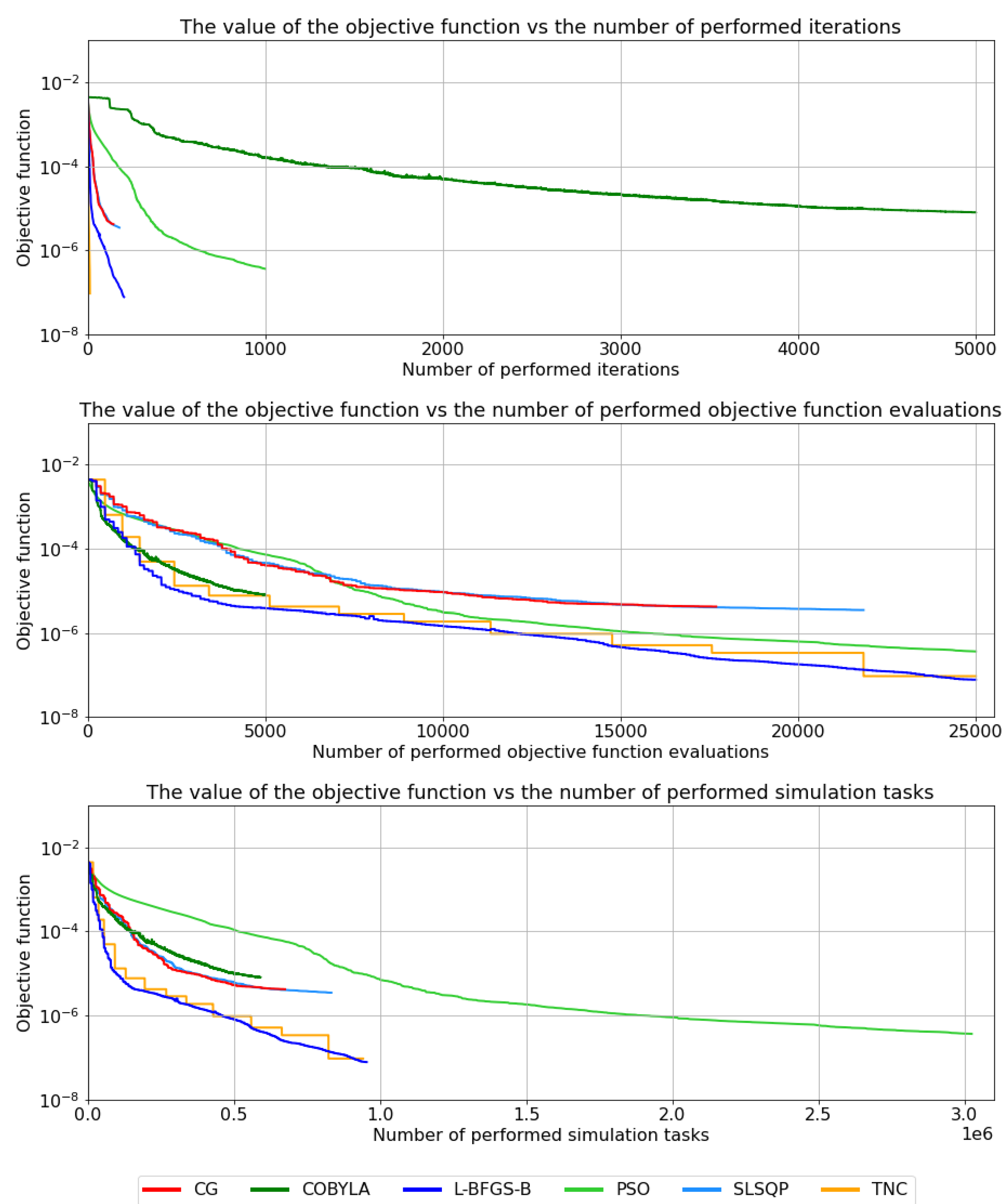

Fig 3. Comparison of performance of several optimization algorithms in the process of inversion of short-normal log.