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Neural network solution of an inverse problem with integration of geophysical methods on recovered data: Training with noise addition.

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SUMMARY

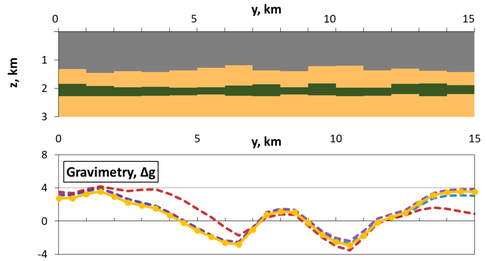
Previously, it was shown that that integration (joint use of data) of several geophysical methods allows one to obtain a higher quality of the solution of the inverse problem of exploration geophysics in comparison with the individual use of each of these methods.

However, there may be a situation when for some measurement points there is no data from one of the geophysical methods used. At the same time, the data spaces of different integrated geophysical methods are interconnected. Therefore, the missing data of one method can be recovered from the known data of another one by constructing a preliminary adaptive mapping of one of the spaces to another.

In this study, we investigate the solution of the inverse problem with integration of geophysical methods (gravimetry (G), magnetometry (M) and magnetotelluric sounding (MT)) on the recovered data obtained based on noise addition during training of the neural networks performing the mapping from the data space of the method(s) with all data present to the data space of the method with missing data.

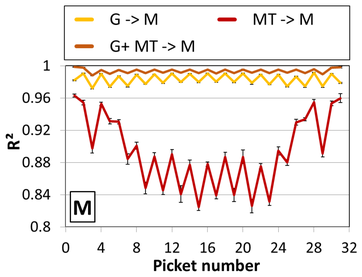
PARAMETRIZATION SCHEME

An example of the geological section within the considered parameterization scheme (top), and the corresponding components of the fields used in this study (bottom). Solid lines – true values of the field components, dashed lines – recovered values.



GEOPHYSICAL FIELDS RECOVERY

Quality (R^2) of recovery of geophysical field components.

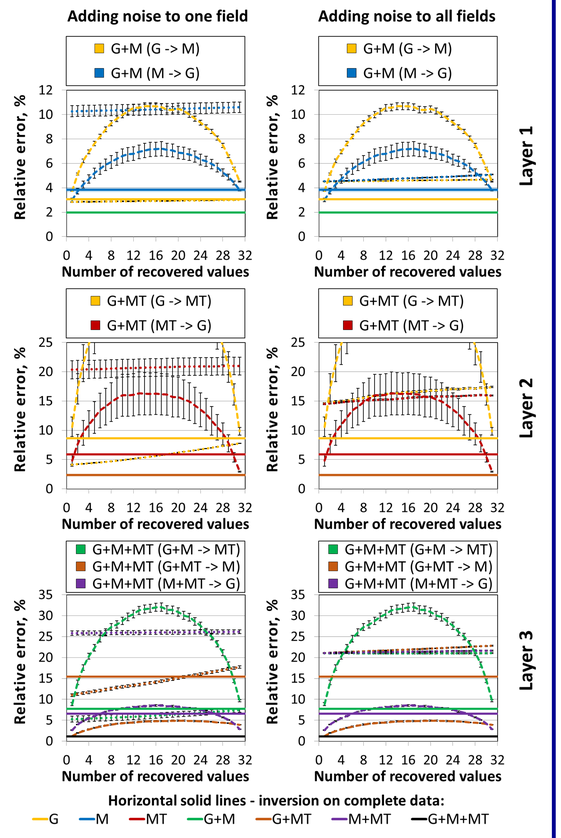


INVERSE PROBLEM SOLUTION

Dependence of the quality of the solution of the IP on the number of recovered values of geophysical field components.

Horizontal solid lines – inversion on complete data, other lines – inversion with joint use of known and recovered data: dotted lines – using training with noise addition, dashed lines – without. The same color corresponds to the same complete known data.

G, M, MT – individual use of gravimetry, magnetometry and MTS data;
G+M, G+MT, M+MT, G+M+MT – integration of methods.



CONCLUSIONS

The following conclusions can be drawn:

1. The proposed approach combining missing neural network data recovery from known data of other geophysical methods and training neural networks with noise at the stage of inversion proved in general to be effective. This may be useful for application with real geophysical data, when some data values are often missing.
2. The use of data of any two geophysical methods to recover the data of the third one shows a better result than using each method separately.
3. Training with noise addition allows obtaining better resilience to the number of recovered field values, but, in most cases, the results are still worse than when using only full known data. Further research is required on the selection of optimal levels of noise added during training.
4. In some cases, an approach based on the reconstruction of one geophysical field from the data of other geophysical fields and their further joint application for inversion yields a positive result.

ACKNOWLEDGMENTS

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