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Validation of resistivity inversion results by model resolution matrix and unit covariance matrix

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Extended Abstract

Summary

The resistivity method is frequently used in fields of engineering geology and exploration of mineral resources. The simplicity of the equipment, the low cost of the survey in comparison with other methods, and the abundance of interpretation methods makes it as a popular geophysical method. There are many methods for inversion of resistivity data. Validation of inverted models is an important step in modeling. In general, validation of the resistivity results is performed by calculating the difference between observed and estimated values, but in this study, a validation technique based on data resolution matrix and model resolution matrix is proposed. The applied method for validation of the results has not been used so far, in this research work, resistivity and induced polarization data have been collected using dipole-dipole electrode array in Hamyj copper deposit located near the city of Birjand. The results of data resolution matrix and model resolution matrix have shown that generalized inversion is a suitable method for processing of resistivity data, because both data and model resolution matrix have been close to an identity matrix.

Introduction

After gathering the resistivity data, application of a suitable inversion method for finding an adequate subsurface model is very important. Visual and analytical methods are used for the interpretation of resistivity data over simple structures such as faults. However, these methods require a certain degree of symmetry and they are suitable only for simple geological conditions. Generalized inversion is one of the important modelling techniques to invert geophysical data. In current study, generalized inversion is used for inversion of resistivity data. Normally the validation of the resistivity results is performed by calculating the difference between observed and estimated values, i.e. error function, but data resolution matrix and model resolution matrix are suitable tools for validation of the results. This method for validation of the results has not been used so far. In this research work, unit covariance matrix has been used to identify the correctness of the each parameter. Moreover, data resolution matrix describes the accuracy level of the estimated values. The covariance of the model parameters depends on the covariance of the data and the way that the error is mapped from data to model parameters. This mapping is just dependent on the data kernel and the generalized inversion, which is independent of the data.

Methodology and Approaches

The proposed technique was tested on synthetic and real datasets. To explore the capability of the applied method more, 10 percent noise was also added to the synthetic data. The results of synthetic dataset showed the capability of the applied technique in the absence and presence of noise. For collecting the real resistivity data, an electrode spacing of 20 m has been used. Then inversion of the resistivity data acquired along a survey line was carried out using the generalized inversion method. Finite difference method was used for forward modelling, and also, perturbation approach was used for calculation of the Jacobin matrix in the inversion process. The results showed the presence o a fault in the study area. Furthermore, the results had a good correlation with the geological evidence from the study area. In this research, the code of the generalized inversion method has been written in MATLAB.

Results and Conclusions

In the present study, a new method for the inversion of resistivity data has been proposed. The proposed method, which is a, generalized inversion method, has been tested on synthetic and actual datasets. The results have shown that the generalized inversion method is a successful technique in the inversion of the resistivity data, because both data resolution matrix and model resolution matrix have been close to an identity matrix. The results, obtained from applying the unit covariance matrix, have shown that the variance of some data is not zero. In other words, the field datasets acquired from the southeast of the survey line, have less accuracy. Finally, we can conclude that these three matrixes for the validation of the model and finding the best model parameters are very useful.