10.2 CONSTRAINED INVERSION OF GEOPHYSICAL DATA WITHOUT REGULARIZATION PARAMETER USING PARETO-OPTIMAL SWARM INTELLIGENCE: APPLICATION TO MAGNETOTELLURIC PROBLEM

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ABSTRACT

A drawback of traditional inversion methods in geophysics is that the solution is trapped in a local minima in the objective space due to initial model dependence. In recent years, global optimization methods such as particle swarm optimization, genetic algorithm, neighborhood algorithm, and simulated annealing have been preferred to overcome this disadvantage. The main advantage of these methods is that the parameter space is searched widely and thus almost the entire objective space is explored with the physically meaningful input arguments. However, due to the ill-posed nature of the problem with a high-dimensional model space, solution sampling is limited by the curse of dimensionality. In general, if the solution cannot be manipulated, not all dimensions of the model space will be represented by the observed data. In this case, a constraint in the objective space with a regularization parameter is required, as in traditional inversion methods. However, an initial model affects not only the solution result, but also the estimation of the regularization parameter when constrained inversion is used. This is because the regularization parameter, which is iteratively adjusted during the iteration, also indirectly depends on the initial model that initiates the inversion process. In particular, if the data are noisy, the appropriate regularization parameter cannot be determined, leading to a tradeoff between data fitting and model variance. In addition, subjective and unpredictable weights of the objective function terms can also lead to misleading results. This study provides a method that can be applied without regularization parameters in the constrained inversion of geophysical data by integrating particle swarm optimization, one of the global optimization methods, with the Pareto optimality approach. To verify the applicability of this approach, magnetotelluric data were selected and the solution accuracy was investigated using a type of synthetic analysis. The results showed that synthetic models can be successfully reproduced even with a high number of model parameters and a large search space. In order to have more confidence in the results of these analyzes, magnetotelluric field data obtained from measurements at a single station in the Çanakkale-Tuzla geothermal field were also modeled. The resistivity- depth section obtained by modeling the field data with advanced tests was compatible with the well logs in the study area. These results confirm that the presented approach can also be successfully used for constrained inversions by minimizing the objective function terms without estimating the regularization parameters.

KEYWORDS: Geophysical modeling, Magnetotelluric, Pareto optimality, Swarm Optimization, Regularization

10.3 A NEW SOFTWARE FOR 3-DIMENSIONAL INVERSION OF MAGNETOTELLURIC AND GRAVITY DATA: PART 1: SOFTWARE INTERFACE AND GRAVITY INVERSION

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ABSTRACT

There are many studies about the joint inversion of Magnetotelluric and Gravity data. This study tries to explain the completed gravity inversion part of the joint inversion algorithm, which is currently under development. Firstly, the part of creating a model mesh using tetrahedron elements is presented along with the difficulties encountered and suggestions. Then, in the forward modeling phase, the methods by which the vertical component of gravitational acceleration can be calculated from the gravity potential calculated with the finite elements method and test models for the modeling algorithm are presented. Finally, the gravity inversion algorithm is compared with the previously developed inversion algorithm that used rectangular prisms, and the developed software's user interface is introduced.

KEYWORDS: