Inversion of arbitrarily oriented anisotropic conductivity media by an approach of the tensor decomposition

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SUMMARY

Considering an anisotropy is an essential and hot topic for not only in the term of the electrical conductivity but also other geophysical parameters, and recent joint analysis and interpretation of multidisciplinary fields requires a three-dimensional anisotropic model with arbitrary orientation, not only the coordinate-oriented model.

According to the Onsager reciprocal relations and the positiveness of the Joule heat, the 3x3 2nd-rank anisotropic conductivity tensor is normally a real symmetric positive definite tensor. The electrical conductivity can dramatically change by the order of magnitude due to various conditions of fluid content and temperature, and thus a logarithmic scale of the conductivity can be easily treated and stable in the inversion process. The anisotropic tensor, however, can have negative off-diagonal elements, and the straightforward approach to give a logarithmic scale of each tensor element as model parameters cannot be applied. In stead of it, this study takes an approach of eigen value decomposition of the conductivity tensor, which decomposes the original matrix to the diagonal tensor with positive eigen values and the orthonormal tensor, and the orthonormal tensor can be only a rotation tensor. Thus, the six unknown elements of original tensor can be converted to three positive eigen value and three rotational angles for arbitrary orientation. Positive eigen values can be treated in logarithmic scale for ease to stabilize the inverse problem like common inversion method of the electrical conductivity.

In this presentation, we show the formulation of our approach and the results of some simple synthetic numerical tests.

Keywords: Anisotropic electrical conductivity, three-dimensional inversion, eigen value decomposition

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