2-D VERSUS 3-D MAGNETOTELLURIC DATA INTERPRETATION

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Abstract. In recent years, the number of publications dealing with the mathematical and physical 3-D aspects of the magnetotelluric method has increased drastically. However, field experiments on a grid are often impractical and surveys are frequently restricted to single or widely separated profiles. So, in many cases we find ourselves with the following question: is the applicability of the 2-D hypothesis valid to extract geoelectric and geological information from real 3-D environments? The aim of this paper is to explore a few instructive but general situations to understand the basics of a 2-D interpretation of 3-D magnetotelluric data and to determine which data subset (TE-mode or TM-mode) is best for obtaining the electrical conductivity distribution of the subsurface using 2-D techniques. A review of the mathematical and physical fundamentals of the electromagnetic fields generated by a simple 3-D structure allows us to prioritise the choice of modes in a 2-D interpretation of responses influenced by 3-D structures. This analysis is corroborated by numerical results from synthetic models and by real data acquired by other authors. One important result of this analysis is that the mode most unaffected by 3-D effects depends on the position of the 3-D structure with respect to the regional 2-D strike direction. When the 3-D body is normal to the regional strike, the TE-mode is affected mainly by galvanic effects, while the TM-mode is affected by galvanic and inductive effects. In this case, a 2-D interpretation of the TM-mode is prone to error. When the 3-D body is parallel to the regional 2-D strike the TE-mode is affected by galvanic and inductive effects and the TM-mode is affected mainly by galvanic effects, making it more suitable for 2-D interpretation. In general, a wise 2-D interpretation of 3-D magnetotelluric data can be a guide to a reasonable geological interpretation.

Keywords: 2-D modeling, 3-D modeling, magnetotelluric theory

1. Introduction

In recent years, the electromagnetic geophysical community has developed faster and more reliable codes to calculate the forward electromagnetic response of three-dimensional (3-D) Earth models. Consequently, the current state-of-the-art for magnetotelluric (MT) data interpretation is 3-D