The Use of 3D Magnetotellurics in Mineral Exploration: Synthetic Model Study and Inversion of 3D MT Survey Data from the Wirrda Well IOCG (SA, Australia)

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James David Komenza

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THE UNIVERSITY of ADELAIDE

ABSTRACT

As a consequence of diminishing shallow mineral resources, the exploration industry has turned its focus to deeper targets. For this reason, the magnetotelluric (MT) method has gained much attention due to its unique penetration in regions of thick cover sequences. As the setting and geometries of mineral deposits are often complex, three-dimensional (3D) models are required for their interpretation. Though still computationally demanding, 3D inversion is now becoming a practical and common tool for presenting MT data. However, there has been little critical analysis of the ability of 3D MT surveys to recover structural geometry. To assess the value of 3D MT in the exploration of mineral deposits, this study compares results of synthetic model studies with a 3D MT survey from an iron oxide copper gold (IOCG) deposit in South Australia. Synthetic data sets are presented for two scenarios incorporating a conductive 3D target, with and without conductive cover. A comparison of model responses demonstrate that while MT is greatly sensitive to conductive and symmetrical bodies at depth, its resolution for detecting finite 3D bodies is significantly reduced under conductive cover. Although 2D inversions can recover the geometry of finite conductive bodies, it is possible to successfully interpret 2D survey data using 3D inversion algorithms. Utilising all components of the impedance tensor, off-profile 3D conductive structure can be obtained from 2D survey data alone. Results of the synthetic studies were applied to a 3D MT data set acquired across the Wirrda Well IOCG deposit (SA, South Australia). Although the thickness of conductive cover sequences were resolved from 2D and 3D inversion, conductivity structure associated with alteration and mineralisation could not be recovered. Thus, although 3D MT shows promise for recovering 3D conductivity structures at depth, its use in delineating deposit scale targets under conductive cover is greatly limited.

KEYWORDS

Magnetotellurics, mineral exploration, two dimensional inversion, three-dimensional inversion, synthetic model studies, Wirrda Well, IOCG

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