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Geoelectric Directionality and Regional MT Responses in Complex Geological Areas: Application to the Nasr-Abad Salt Dome

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Summary
Salt extrusions (diapir, dome and glaciers) have a high electrical resistivity contrast with their surrounding sediments and consequently are good exploration targets for electromagnetic (EM) methods. However, diffusive EM fields, employed in magnetotelluric (MT) exploration technique, have restrictions in resolution and sensitivity and cannot model the earth at the full scale. Furthermore, galvanic distortion effects caused by shallow and small scale lateral inhomogenities contaminate measured EM fields and cause unreliable imaging of subsurface electrical resistivity.
In this study, we investigate dimensionality, directionality and distortion analysis of a large dataset from 284 broad band MT stations recorded along seven profiles in Nasr Abad region, west central Iran. The region is composed of five salt diapirs, developing close to the Abshirin Shurab fault zone which is a dextral strike slip fault with a NNW-SSE strike direction in the west Central Iran.
We applied unconstrained and constrained Groom-Baily (GB) decomposition analysis, as developed by McNise and Jones (2001) for different period bandwidths of each site to obtain the pattern of strikes and distortion effects across the area. We also tested the hypothesis of particular regional strike by performing the GB decomposition for fixed strike angles from 0˚ to 90˚ in 5˚ intervals. The availability of the full suite of strike and distortion results enhances the process of distortion removal from measurements.
The results indicate a moderate to low level of distortions in the studied area with distortion parameters distributed in a [-10˚, 10˚] range. There are little phase differences (<5˚) between orthogonal directions at periods smaller than 10 sec, representing that the data are deemed one-dimensional i.e., free from geoelectric strike angle. Larger phase differences indicate that an accurate interpretation of conductivity structure requires 2-D modeling. Directionality analysis reveals a general trend of 70˚±5˚ (with an inherent 90˚ ambiguity). We further applied real induction vectors (perpendicular to the geoelectric strike direction of a regional 2-D structure) to unravel the 90˚ strike ambiguity recovered by the GB method. Cumulative orientation of real induction arrows whose lengths>0.1 shows a preferred direction almost perpendicular to the N20˚W azimuth. We sought for the decomposition parameters (regional strike, twist and shear angles) which were site- and frequency- independent according to the GB model. Fixing the regional strike to -20˚ we found stable estimate of the shear and twist angles. In the final step, regional strike, shear and twist angles were fixed at -20˚, 0˚ and 0˚ respectively for all stations to derive the regional impedances. The magnitudes of all impedance tensor components recovered from the last constrained GB decomposition were compared with their corresponding original values. The results have shown that high values of diagonal impedances reduce significantly, making them suitable for further 2D modeling and interpretation.

Key Words: Electrical Resistivity Structure, Magnetotelluric, Salt Dome, Shurab, Central Iran

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