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High Resolution Magnetotelluric Imaging of the Nisyros Caldera and Geothermal Resource (Greece)

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This work reports the qualitative and quantitative re-examination of legacy magnetotelluric soundings data obtained in the caldera of Nisyros, a small island volcano at the eastern end of the Hellenic Volcanic Arc (HVA), Greece, in an attempt to explore the high temperature geothermal resource of the area. The data set comprises 39 single-site soundings and is re-examined with improved data processing methods, new hypothetical event analysis techniques to study the spatial configuration of the telluric field and two-dimensional inversion tools. Iteratively reweighted least squares have been implemented to compute stable and smooth Earth response functions, which were found to exhibit 2-D to weakly 3-D attributes as a result of induction in low-contrast local geoelectric inhomogeneities, superimposed on a dominantly 2-D background structure. The transfer functions appear to be free of coastal and island induction effects due to the low offshore/onshore resistivity contrast at, and below sea level. The spatial properties of the telluric field are studied with hypothetical event analysis based on 3-D decompositions of the impedance tensor [1]. The results indicate that convection and hydrothermal circulation is controlled by a system of antithetic NE-SW oriented active normal faults which form a graben-like structure and define the 2-D background, as well as a conjugate system of NNW-SSE normal faults which is particularly active at the SW quadrant of the island and define the main convection path. It was determined that under these conditions the data can be interpreted with 2-D inversion, which was carried out with [2]. The inversion has successfully reconstructed detailed images of the structural and functional elements of the hydrothermal system. The structural elements include a number of shallow hot water reservoirs in the argillic and phyllic alteration zones and a laterally extended deep (approx. 1km) circulation zone, all embedded in a low-resistivity matrix with very low lateral contrasts. The functional elements include images of the most important convection conduits created by the intersection of major fault planes. The results are corroborated by the logs of two deep exploration wells. Overall, on the basis of a carefully reworked data set, our analysis has provided detailed images of the volcano's interior and valuable insight into its structure, function and geothermal potential.

References

[1] Tzanis, A., 2014. The Characteristic States of the Magnetotelluric Impedance Tensor: Construction, analytic properties and utility in the analysis of general Earth conductivity distributions, arXiv:1404.1478 [physics.geo-ph]; last accessed, January 2017.
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