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Flank instability structure of Mt Etna inferred by a magnetotelluric survey

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Thirty soundings belonging to a larger magnetotelluric (MT) data set of the unstable eastern flank of Mt Etna are performed along N-S and NW-SE profiles, respectively.
Detailed strike and dimensionality analyses reveal consistent, but period dependent, strike directions, indicating a change in the geoelectrical strike with period, that means, giving their direct proportionality, with depth. In the period range 0.01-1 s the geoelectric strike angle is orthogonal to the N-S direction, while in the range 4-100 s results perpendicular to NW-SE. Moreover, as the dimensionality analysis suggested, the data are roughly compatible with 2D structures in the above-mentioned two period bands, thus permitting us 2D inversion of the N-S high frequency data set in the experimental (geographic) frame of reference and of the NW-SE rotated and undistorted data set in the whole period range.
The obtained resistivity models reveal three major layers in a resistive-conductive-resistive sequence, the deepest extending to 14 km bsl. The shallow layer corresponds to the volcanic cover, and the intermediate conductive layer corresponds to underlying sediments segmented by faults. These upper two electrical units are cut by ∼E-W-striking faults. The third layer (basement) is interpreted as mainly pertinent to the Apennine-Maghrebian Chain associated with ∼SE-NW-striking regional faults. The detailed shapes of the resistivity profiles clearly show that the NE Rift is shallow-rooted (∼0-1 km bsl), thus presumably fed by lateral dikes from the central volcano conduit. The NW-SE profile is characterized by a series of listric faults reaching up to 3 km bsl in depth, then becoming almost horizontal. Towards the SE, the resistive basement dramatically dips (from ∼3 km to ∼10 km bsl), in correspondence with the Timpe Fault System. Several high-conductivity zones close to the main faults suggest the presence of hydrothermal activity and fluid circulation that could enhance flank instability. Our results provide new findings about the geometry of the unstable Etna flank and its relation to faults and subsurface structures. Nevertheless it represent only a first, promising step, for the construction of a new structural model at Etna, for which more numerous and homogeneously distributed MT measurements are needed and a 3D modeling could be more suitable.