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Shallow geothermal exploration using SkyTEM data: the VIGOR experiment

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Abstract:
Within the "VIGOR" project, aimed at assessing the geothermal potential of four regions in southern Italy, helicopter geophysical electromagnetic (SkyTEM) data have been acquired, modeled and interpreted. The SkyTEM system provides, after data acquisition, analysis, processing and modeling, a distribution volume of electrical resistivity, spanning an investigation depth from ground surface of few hundred meters, depending on resistivity condition. Results were used also to characterize the main geological units outcropping in the region and extend the investigation at depth. Resistivity is an important physical parameter for geothermal investigation, since it proved to be very effective in mapping anomalies due to hydrothermal fluid circulation, which usually has high salt content and produces clayey alteration minerals. Besides, resistivity data may help in characterizing hydrogeological or tectonic features. The attempt is also to define relations between resistivity distribution, lithological units and thermal conductivity.
The geophysical survey was carried out in Sicily, Italy, in late 2011, covering two areas. SkyTEM data have been acquired in a series of flight lines and were then processed and inverted. In the "Termini" area the flight line spacing had 150 m separation. In the "Western Sicily" area two different line spacing were used: the 1 km spacing was used for the regional mapping, whereas for infill areas, around the main hydrothermal springs, the flight lines had 100 m spacing.
After acquisition, data were analysed and processed. Inversions were then carried out using the quasi 3-D Spatially Constrained Inversion (SCI). The obtained resistivity volume has then been the base for a detailed lithological and geothermal interpretation. Lithological and geological maps were used to constrain surface condition and to understand the resistivity ranges of the different lithological units. On the base of resistivity values, lithological units were combined to establish the main litho-electrical units, which were then modelled at depth, down to achievable investigation depth. This detailed interpretative modelling was the occasion of recognizing resistivity anomalies within carbonate units, which host the regional hydrothermal reservoir.
The litho-electrical 3D model is also under investigation to verify how it can represent a viable way to image heat exchange properties at shallow depth. If we succeed in defining the relations between electrical resistivity, lithology, thermal conductivity and hydrogeological bodies, we would obtain a viable way to define, at depth, of the main parameters (thermal properties and fluid distribution) for defining shallow geothermal potential.