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Deep Electrical Resistivity and Passive Seismic measurements for the characterization of a local geothermal resource at Canino (Viterbo, Italy)

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Electrical resistivity and passive seismic methodologies are powerful tools for geothermal exploration, helping to constrain the geologic framework and the physical parameters of the geothermal system.
We investigated the hydrogeological system of the Canino area (Viterbo – Central Italy) in order to constrain the depth of the reservoir rocks for potential geothermal exploitation. An intense hydrothermal activity is well indicated in the study area by many thermal springs with temperatures of $\sim$50°C.
The study area is characterized by a large travertine plain overlying Ligurian Units and Mesozoic carbonates of the Tuscan Nappe. These Mesozoic carbonates characterize also the Canino mountain range, bounding to the north the travertine plain, and representing the re-charge area of the hydrothermal system.
The hydrogeological system is characterized by a shallow fluid circulation in a heterogeneous aquifer with different permeability. Previous geological and geochemical studies define the Canino geothermal system as a complex area where a simple model is not sufficient to explain the flow rate of thermal waters localized in the small carbonate outcrop. Therefore, to delineate the local geothermal use of the resource, which seems easily accessible, precise information is required. This work describes the geophysical, geological and hydrogeological investigation in order to characterize the geothermal resource.
Two different geophysical methods were used to infer the position and the geometry of the carbonate rocks below the ground surface, where the geothermal resource should be localized.
A Deep Electrical Resistivity Tomography was carried out along a profile 3000 m long to achieve an investigation depth of about 700 m. The resistivity data acquired by a geoelectrical system prototype were analysed and inverted by different algorithm to obtain the best tomography resistivity image.
We also performed a passive seismic survey using spatial autocorrelation techniques. We acquired sixteen seismic measurements using an array of seven broad-band seismometers. We were able to evaluate the Rayleigh phase and group velocities in the 0.5 – 5 Hz frequency range, allowing us to investigate up to $\sim$700 m deep.
The results achieved from joint analysis of electrical resistivity and passive seismic surveys strongly indicates the position of the top of the carbonate reservoir rocks in the 350-410 m depth range. This information yields to define the position of the exploration target and thus to roughly estimate the cost of the future drilling operation.