

Geothermal potential of the Tertiary Piedmont Basin: structural and lithological controls

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Geothermal energy, as a renewable and green source for energy production and heating/cooling activities, has a great development potential in many European countries. The dynamic tectonic history of Italy provides a favorable geologic framework for geothermal resources to be formed. Besides some volcanic regions, characterized by significantly hot manifestations, there are many low enthalpy geothermal fields. Only a few of them have been addressed and are mainly exploited directly as heat. Within this context, less evident and more complex systems suitable for developing new geothermal projects, become key areas for the energetic transition. Nevertheless, their exploration and future exploitation can only occur through the implementation of multidisciplinary methodologies, leading to a detailed characterization of the reservoirs.

Our main goal is to determine the geothermal potential of the Tertiary Piedmont Basin (TPB, north-western Italy) by revealing the thermal structure of the region, as well as the heating mechanisms and heat flow controls in the basin. The TPB records the dynamic evolution of the Alps-Appennines junction. It accommodates on average 3 km of sedimentary units (Eocene to Pliocene in age), which show marked lateral facies variations and tectonically-controlled depositional architectures (Di Giulio et al., 2024 and reference therein). These units and the underlying Alpine basement experienced multiple pulses of deformation, developing kilometeric structures over a stretched lithosphere, which likely had a key role in increasing the geothermal gradient of the area (Amadori et al., 2023). Several hot springs up to 70°C (e.g., Acqui Terme) and moderately high surface heat flux, between 62 and 84 mW m⁻² (Pasquale et al., 2014) have been observed in the TPB, evidencing its potential as a new geothermal resource. The location of the hot springs, north to the metamorphic basement outcrops, identify the last one as the recharge area of the meteoric water. Furthermore, the presence of a thin crust (30-35 km), revealed by recent seismic tomography studies (e.g., Nouibat et al., 2023), enhances the role of the deep structures in the formation of the geothermal reservoir.

In this study, we display the results of the first field campaign, carried out in the TPB, and the analyses of the available geological/geophysical data. These include the recognition of key lateral and vertical facies variations of the stratigraphic units and of first order structures present in the basin. These outcomes, together with the measurements of petrophysical parameters and fluid inclusion micro-thermometry from the sampled rocks, will be the main input for the implementation of the initial geological model. This workflow based on stratigraphic and structural analyses, as well as diagenesis, will be crucial for the evaluation of the geothermal potential of the TPB and could be applied on similar basins.

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