

InGEO: Innovation in geothermal resources and reserves potential assessment

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In agreement with the European Green Deal, setting the ambitious target of reducing CO₂ and climate-altering gas emissions by 55% by 2030 (from 1990 levels) and climate neutrality by 2050, the geothermal energy sector is expected to grow steadily. For many decades geothermal energy has been used on a large scale by tapping into hot water-bearing layers at 0 – 4 km depth. The geographical limitation of large-scale geothermal plants is going to be overcome by recent advancements, which demonstrate that it is possible to produce energy also by deep closed-loop heat exchanger systems in the subsurface (Gola et al., 2022). While research in this field develops, it is strategic to estimate - on a regional scale, down to a depth of 10 km - how much energy can be concentrated and extracted from upper-crustal layers.

The InGEO project (Innovation in GEOthermal resources and reserves potential assessment for the decarbonization of power/thermal sectors) aims to define a method to quantify the energy realistically producible from deep geothermal energy sources at the regional level to be used for specific technologies, e.g. to generate electricity or for district heating. Starting from a review of the existing techniques for the evaluation of the technical and economical-technical potential based on the volume method (Trumpy et al., 2016), further innovations will be included. Key challenges, considering a regional scale example as a test site, consist of: (i) developing a robust assessment of the deep geothermal resources, considering the local geological conditions, the thermal regime and the heat exchange capacity; (ii) defining operative solutions for heat extraction, including the exploitation of natural hydrothermal systems, the deep closed-loop heat exchangers as well as the thermal energy storage technologies, to optimise the thermal performance; and (iii) validating the regional scale approach with site-specific information.

The study area includes the sector of the buried fold and thrust belt of the Northern Apennine belonging to the Romagna and Ferrara Folds (Figure 1). This area has been the target of previous studies focused on both hydrocarbon and geothermal exploration activities. More than 500 boreholes with available lithostratigraphic and bottom hole temperature information have been selected. Locally, thermal data highlight positive heat flow anomalies attributable to the deep fluid circulation within the deep-seated carbonate sequences of Mesozoic age (Pasquale et al., 2013).

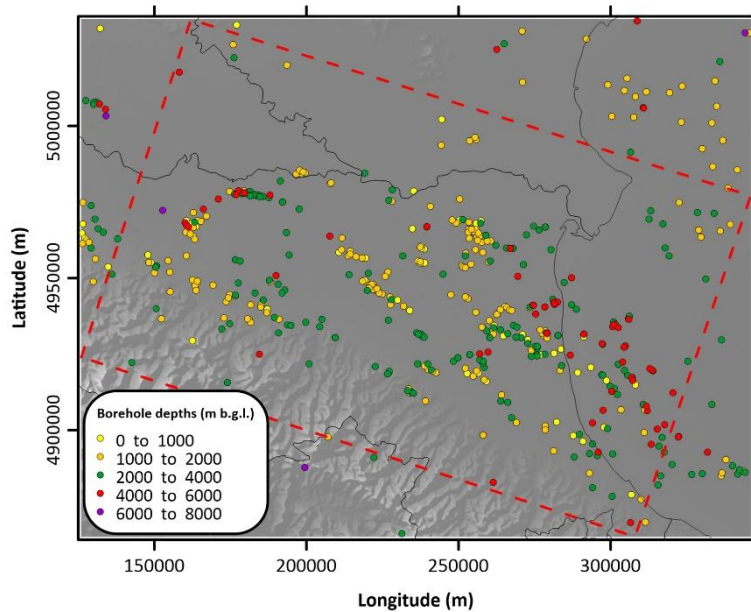


Figure 1. Area of study (dotted rectangle) and location of the selected deep boreholes as function of the total depth (meters below ground level).

The project will demonstrate an innovative exploration workflow to integrate geophysical data (e.g. Spada et al., 2013; Magnoni et al., 2022) to reconstruct the crustal and subcrustal structures (Figure 2). Moreover, taking advantage of the different sensitivity that geophysical data have on physical rock's parameters (temperature and composition), the optimized geological and thermal models will be the input of the resource assessment. The calculation of the deep geothermal energy potential for hydrothermal systems, deep closed-loop heat exchangers and thermal storage technologies will be performed by developing an open-source and web-based GIS tool, namely GEOTHERMOS.

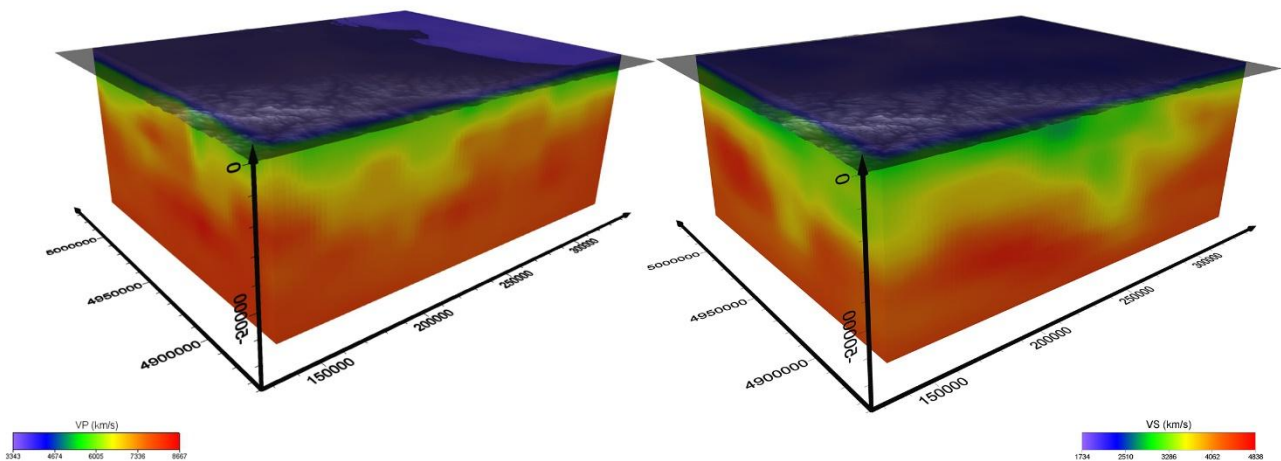


Figure 2. Distribution of the seismic velocities (Vp on the left, Vs on the right) beneath the area of study (from Magnoni et al., 2022).

The project is expected to have a significant impact on the geothermal community. The outcomes of InGEO are designed for use by investors, regulators, governments and consumers. InGEO sets the cornerstone for comprehensive deep geothermal potential estimation at the regional level.

Stakeholders will have the opportunity to compute the potential for any area where deep geological and thermal models will be available. The research units involved into the project will continue to improve the GEOTHERMOS tool by inserting their data also for other regions in Italy and will invite the scientific and industrial community to contribute to the feasibility.

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