InGEO: GEOthermal resources and reserves potential assessment for the decarbonisation of power/thermal sectors

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InGEO Project Description

- The **InGEO** project (Innovation in GEOthermal resources and reserves potential assessment for the decarbonisation of power/thermal sectors) aims to develop an innovative exploration workflow integrating geophysical data and other direct and indirect information, organized to make available a sort of decision support system of geothermal projects. It consists of the reconstruction of the crustal and subcrustal structures by joint analyses and interpretations of available and acquired geological and geophysical data, taking advantage of the different sensitivity that geophysical methods have on physical rock's parameters (temperature and composition). The results will be the input for the geothermal model that will quantify the deep geothermal resource potential of the area.
- The designed workflow (Fig. 1) will be tested in the sector of the Northern Apennine buried structures, belonging to the Romagna and Ferrara Folds (RFF) and partially calibrated with developed (hydrothermal) available data. The methodological approach proposed by InGEO is also expected to define the potential local use of geothermal systems by Deep Closed-loop Borehole Heat Exchangers (DBHE) for power generation, district heating and/or cooling.
- The **InGEO** results will contribute to the second mission of PNRR "MISSION 2: GREEN REVOLUTION AND ECOLOGICAL TRANSITION", by expanding the business planning of deep geothermal resource use in Italy.

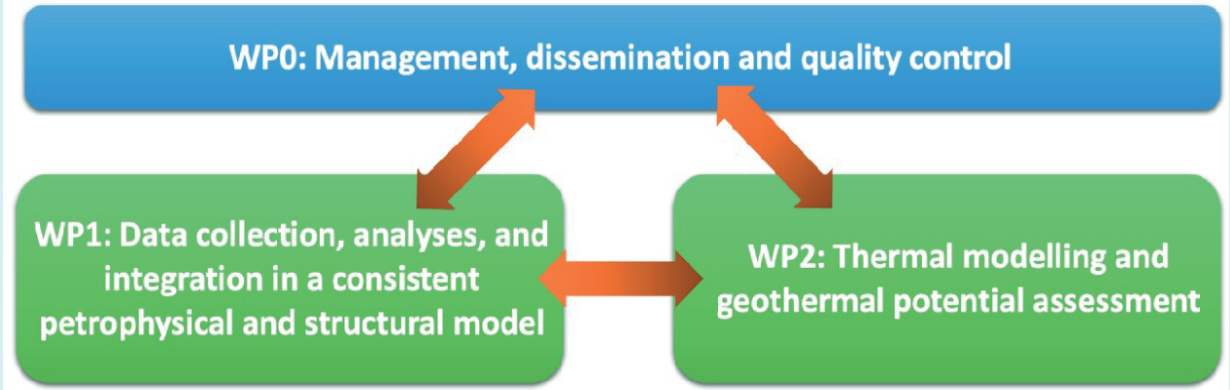

Fig. 1:Thematic Work Package and workflow of the InGEO project

Study Area

The RFF area (Fig. 2) has been the target of previous geothermal studies highlighting relatively low geothermal gradients within the deep carbonate units (on average 14 °C/km) and more significant thermal gradients (on average 53 °C/km) in the overlying impermeable formations [1-2]. This feature in temperature distribution with depth is clear evidence for fluid thermal convection occurring in the deep-seated carbonate units of Mesozoic age, which constitutes the local geothermal reservoir.

Data Collection

The shallow crust of this area has been investigated through a total of 535 deep exploratory wells (VIDEPI database: https://www.videpi.com/videpi/videpi.asp), having final depths ranging from 0.5 up to 6.5 km below ground level (Fig. 3). The majority of boreholes were drilled by Eni for oil & gas exploration purposes. They provide essential information, albeit with variable quality and completeness, regarding lithostratigraphy, temperatures measured during drilling stops and geophysical logs, commonly electrical resistivity, gamma ray and sonic.

Several geophysical investigations, recently carried out in the Alps and Po plain, revealed both the shallow ad deep structures of the study area, in terms of lateral variations of Bouguer anomalies, seismic velocities, and main discontinuities [4-6] (Figs. 4-9). We can observe a good correspondence between the low seismic velocities, characterizing the shallow crust of the RFF, and the negative Bouguer anomalies (Figs. 4-6). The Moho depth deepens from NE to SW (Fig. 7), while the velocity in the shallow and deep lithosphere is low in the central part of the study area and tends to increase beneath the Apennines (Figs. 8-9).

References

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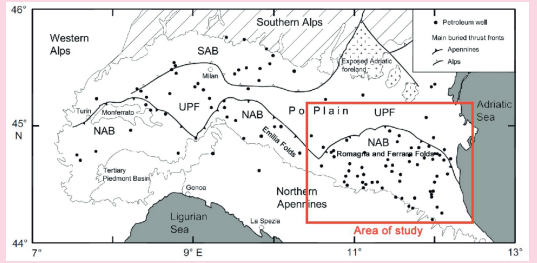

Fig. 2: Main tectonic units of the study area (delimited by a red rectangle) and surroundings. Abbreviations stand for: **NAB**: Northern Apennines buried structures; **UPF**: Undeformed Padan foredeedp; **SAB**: Southern Alps buried structures.

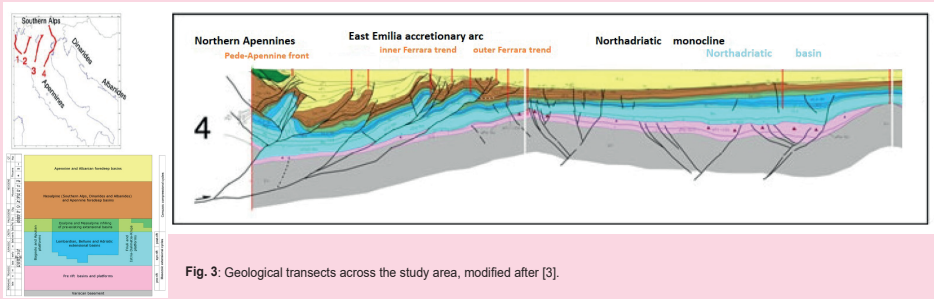

Fig. 3: Geological transects across the study area, modified after [3].

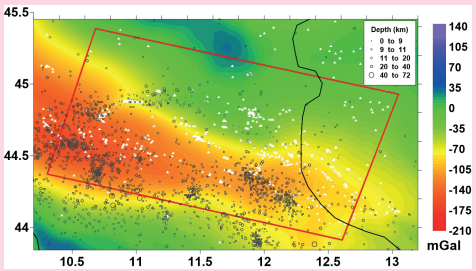

Fig. 4: Bouguer anomalies [4]. Red rectangle delimits the study area. White triangles show the wells location from Videpi database. Grey circles show the earthquakes (1909-2024) location from the NEIC catalogue, with Mw> 2.5.

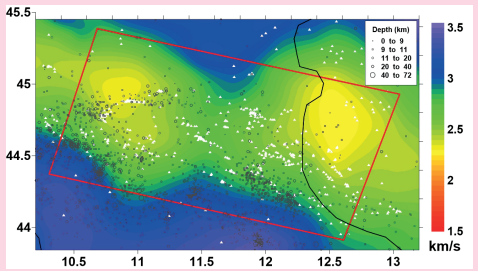

Fig. 5: S-waves velocities at a depth of 2 km [5].

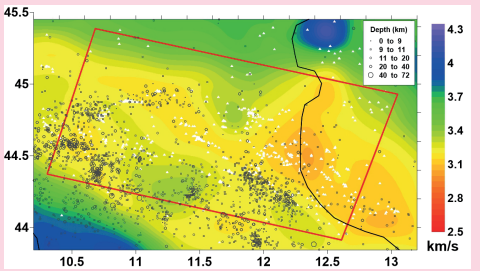

Fig. 6: S-waves velocities at a depth of 20 km [5].

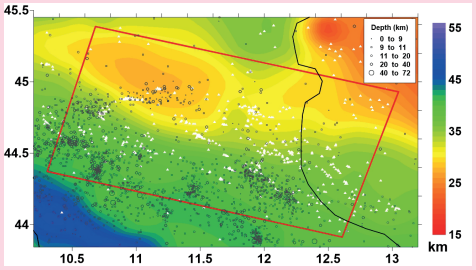

Fig. 7: Moho depth [5].

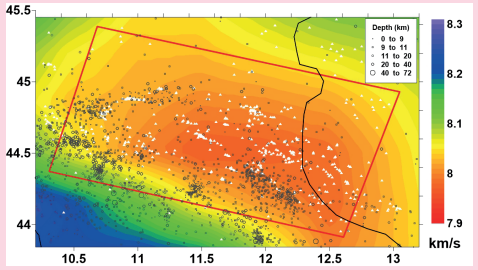

Fig. 8: P-waves velocities at a depth of 100 km [6].

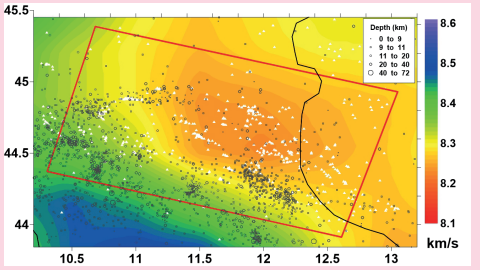

Fig. 9: P-waves velocities at a depth of 200 km [6].