Joint interpretation of geophysical data for evaluating the geothermal energy potential in the Romagna and Ferrara Folds (Italy)

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Geothermal energy, a reliable, clean and sustainable energy source, can contribute to the ambitious commitment of the European Green Deal to achieving a 55 % reduction in CO2 and climate changing gas emissions by 2030. Harnessing this high temperature resource, however, requires a proper evaluation of the geothermal prospect, due to the high risks associated with drilling expensive, unsuccessful, geothermal wells.

Integration of multi-parameter datasets can help properly characterize the subsurface region of geothermal prospects and, inevitably, reduce the uncertainties for exploiting this resource. The InGEO project (Innovation in GEOthermal resources and reserves potential assessment for the decarbonization of power/thermal sectors, www.ingeo.cnr.it) seeks to develop an innovative exploration workflow for combining muti-parameter datasets within the sector of the Northern Apennine buried - structures belonging to the Romagna and Ferrara Folds (RFF). Previous assessment of thermal data identified a thermal anomaly within this region attributable to deep fluid circulation within the deep-seated Mesozoic carbonate sequences (Pasquale et al., 2013; Pasquale et al., 2014). Moreover, the region there are several geological and geophysical data (e.g., seismic lines, stratigraphic columns, well reports and logs, borehole tests and measurements, Seismic tomography and surface gravity), available from previous studies, which will contribute to the consistent evaluation of the geothermal potential of the RFF.

An ongoing study is focusing on the reconstruction of the RFF shallow geological structures (Cortassa et al., 2024) and will help this study to unravel the physical crustal properties. This aim will be pursued by comparing and interpreting different 3D seismic tomography models (Diehl et al., 2009; Kästle et al., 2018; Lu et al., 2018; Magnoni et al. 2023; Nouibat et al., 2023; Paffrath et al., 2021) with the first pan-Alpine surface-gravity database (Zahorec et al., 2021).

The geographical outline of all datasets (Fig. 1) highlighted that all models contain data within the RFF region. Using a clustering algorithm, our first joint interpretation of the geophysical datasets (1) identified regions in the RFF with consistent low Vp, low Vs, and negative Bouguer Anomalies (2) characterized the deeper crustal regions within the RFF and (3) pinpointed any inconsistencies amongst the variation in geophysical parameters datasets. The results of this study will be compared with the geological model reconstructed over the RFF (Cortassa et al., 2024) and laboratory analyses on rock's samples representative of the main lithological units of this region.

Overall, the results of this ongoing research will be used as input parameters for the development of a thermal model and the implementation of an open-source and web-based GIS tool that will assess the deep geothermal resource potential for both hydrothermal resources and deep heat exchangers. Lastly, the workflow of InGEO project will be used as a decision support system for developing geothermal projects in Italy.

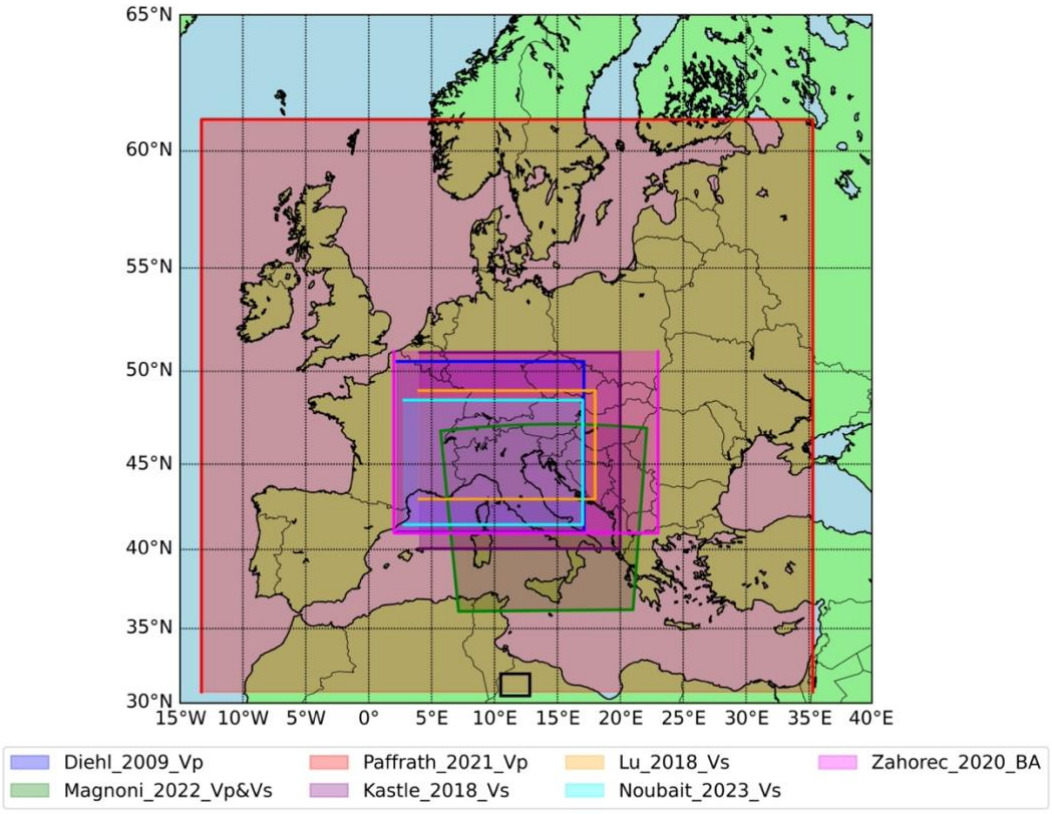

Fig. 1 – Geographical outlines of the geophysical models that include 3D Vp and Vs models (Diehl et al., 2009; Kästle et al., 2018; Lu et al., 2018; Magnoni et al. 2023; Nouibat et al., 2023; Paffrath et al., 2021) and surface gravity data (Zahorec et al., 2021).

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