Integrated geological modelling for assessing geothermal potential in the Romagna and Ferrara Folds (Italy)

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Geothermal energy is recognized as a sustainable and environmentally friendly solution for power generation and district heating/cooling. It provides continuous availability year-round and day-long, with considerable potential for development worldwide.

The InGEO project ("Innovation in GEOthermal resources and reserves potential assessment for the decarbonisation of power/thermal sectors", www.ingeo.cnr.it) aims to develop an innovative exploration workflow that integrates geological/geophysical data and other direct and indirect information, to characterize the reservoir rocks and the overlying sedimentary cover, thereby advancing strategic planning for the exploitation of deep geothermal resources in Italy.

Deep-seated carbonate reservoirs, composing the basement of sedimentary basins, are often targets for geothermal energy deployment. The buried Romagna and Ferrara Folds (RFF) in the eastern Po Plain, extending from the Emilia Folds (west) to the Adriatic coast (east) and from the northern Apennines (south) to the undeformed Po foreland (north), exhibit distinct geothermal gradients, suggesting convective heat flow within deep carbonate units. Pasquale *et al*. (2013) estimate a low geothermal gradient (14 °C/km) in these carbonates and significantly higher gradients (53 °C/km) in the overlying impermeable formations. This is clear evidence of fluid thermal convection occurring in the deep-seated carbonate units of the Mesozoic age.

To characterize the study area, we collect, digitize and analyze data from over 200 seismic surveys from the VIDEPI database (www.videpi.com), 700 deep (>1500 m) boreholes (CNR database, www.geothopica.igg.cnr.it) and 160 borehole logs (sonic and lithological logs) from Livani et al. (2023), covering an area of ~22.500 km^2 (Fig. 1). Using this extensive dataset, we develop a detailed 3D geological model, providing the thickness variation of the main lithological units down to a depth of ~10 km, by identifying primary lithological unconformities through seismic reflection interpretations constrained by well stratigraphy.

The 3D geological model is a fundamental tool for the geothermal assessments of this basin and for developing an exploration workflow in analogous basins. This model will be a main reference for

estimating the geothermal potential of the area and will be used as input to test the consistency of different geophysical datasets (Basant et al., 2025) and an open-source web-based GIS tool, for different resources and applications.

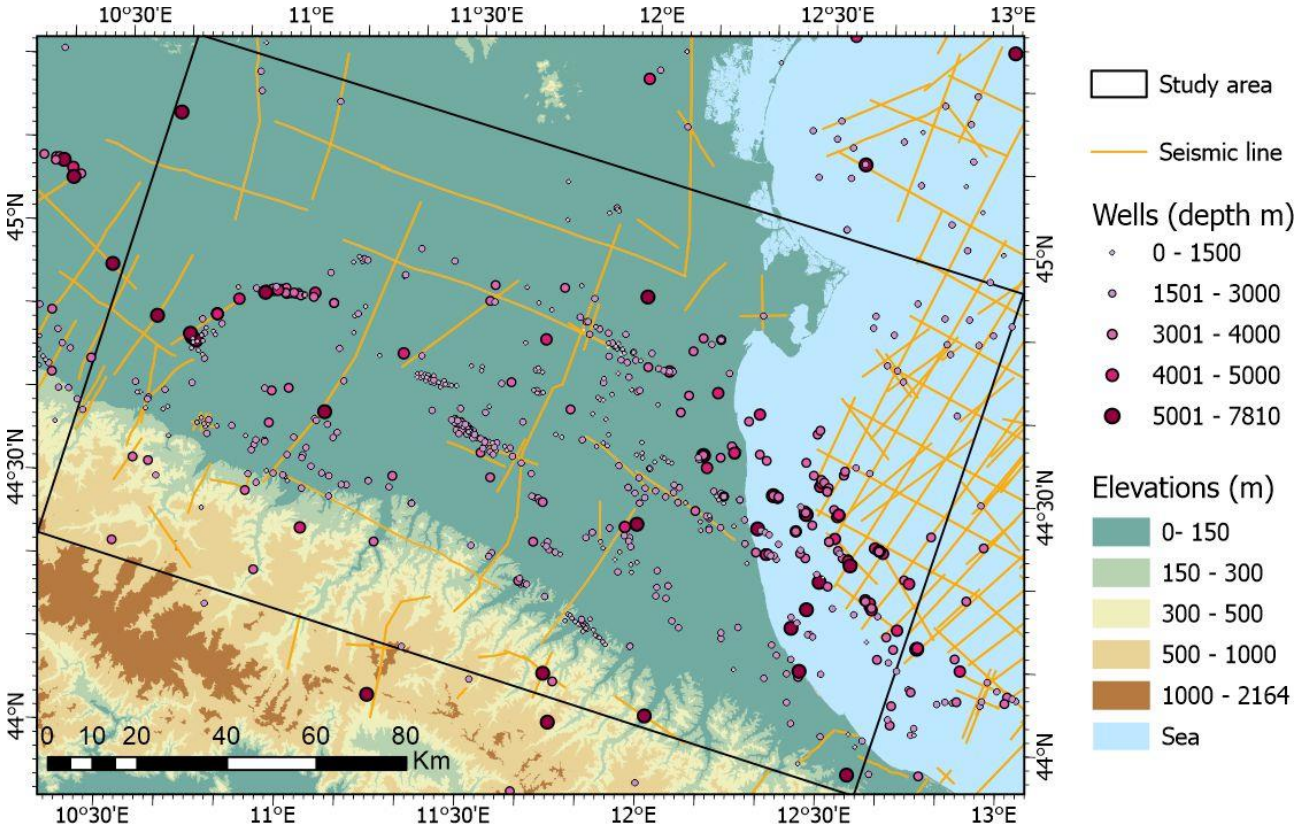

Fig. 1 – Study area of the InGEO project on DEM. Location of available seismic lines and wells (colour and size are shown according to their depth).

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