UNRAVELLING THE IMPORTANCE OF FRACTURED ZONE IN REGIONAL FLUID FLOW: INSIGHTS FROM THE HYDROTHERMAL MODELLING OF THE EUGANEAN GEOTHERMAL SYSTEM (NE ITALY)

Marco POLA [1,2], Mauro CACACE [3], Paolo FABBRI [1,2], Leonardo PICCININI [1,2], Dario ZAMPIERI [1,2], Nico DALLA LIBERA [1]

[1] Department of Geosciences, University of Padova, Via Gradenigo 6-35127 Padova, Italy, marco.pola@unipd.it
[2] Geothermal System Hydrostructures (GSH), Interdepartmental Centre "Giorgio Levi Cases" for Energy Economics and Technology, University of Padova-35127 Padova, Italy
[3] Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Telegrafenberg, Potsdam, Germany

The Euganean Geothermal System (EGS; Veneto region) is one of the largest and most extensive utilized geothermal system in northern Italy. The naturally emerging thermal water is exploited by approximately 200 wells from a 300-1,000 m deep thermal aquifer. The water has a temperature from 65°C to 86°C, and it is used for balneotherapy forming the famous Euganean spa district. The Euganean Geothermal Field (EGF) and thermal fluid have been subject of multidisciplinary studies over the last 50 years, and their results were used to propose a structural controlled conceptual model of the system (Pola et al., 2015). The thermal water is of meteoric origin and infiltrates to the north of the EGF in the Veneto Prealps. The water flows for approximately 100 km in the subsurface of central Veneto and emerges to the southwest in the EGF. The regional flow and the local rising are controlled by the regional Schio-Vicenza fault system (SVFS) that is a system of NW-SE trending, NE dipping faults buried beneath the Quaternary cover of the Veneto alluvial plain. The former is enhanced by the damage zone of the Schio-Vicenza fault. The latter takes advantages of a local network of fractures associated with an interaction zone between the faults of SVFS. In the present study, the conceptual model is implemented in 3D coupled flow and heat transport numerical model to quantify the role of these highly permeable structures on the flow. The geological setting is reproduced by 5 units with different hydrodynamic and thermal properties using an Equivalent Porous Medium approach (EPM). The fractured zones are simulated increasing the hydrodynamic properties of the EPM. In addition, discrete elements are superimposed to reproduce the local network of fractures. The simulations are carried out for 2.5 Ma to obtain quasi-stationary solutions. The results show temperatures in the EGF reservoir higher than in the surrounding areas, despite a uniform basal regional crustal heat flow. In particular, the modelled temperature in the thermal aquifer of the EGF varies from 44°C at the top (depth of 0.4 km) to 118°C at the bottom (depth of 1.6 km). In addition, the discrete elements drive a local outflow of 0.72×10^6 m^3/y in the interaction zone. These results are consistent with temperature logs into the wells, the reservoir equilibrium temperature inferred with geothermometers and historical data on the natural outflow of the Euganean thermal springs. The performed numerical model corroborates the proposed conceptual model, and it suggests that the outflow is strictly related to the local

structural setting. In particular, the regional, deep-seated, fluid flow is preferentially conducted to the surface by the high-connected fractures beneath the EGF, warming up on its way.

References

Pola M., Fabbri P., Piccinini L. & Zampieri D. 2015. Conceptual and numerical models of a tectonically controlled geothermal system: a case study of the Euganean Geothermal System, Northern Italy. Central European Geology, 58, 129-151.