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Sustainable Use of Geothermal Resources in Italy: first inventory of data, applications and case studies

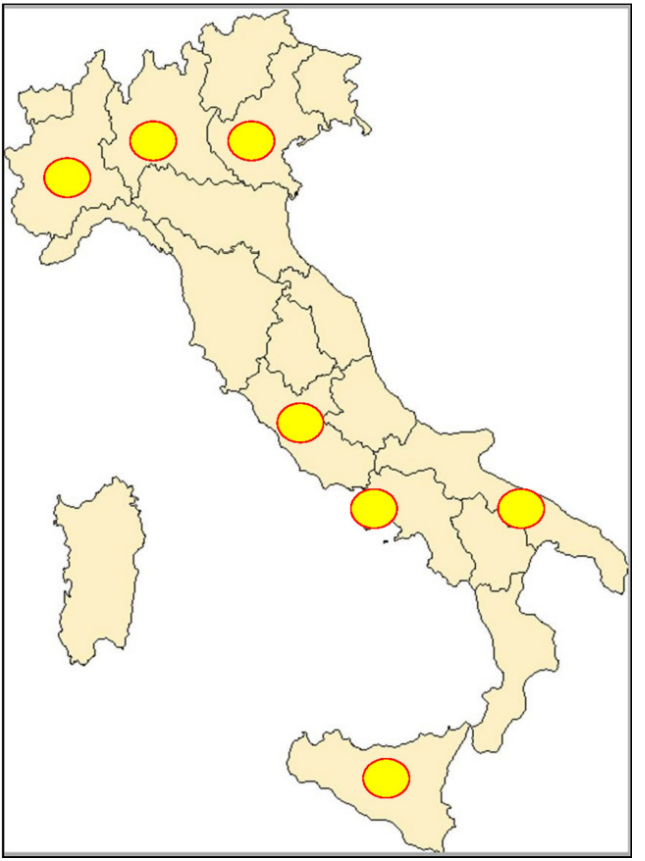
Working Group IDROGEOTER, IAH Italian Chapter,
Paolo Cerutti, Daniela Ducci, Paolo Fabbri, M. Dolores Fidelibus, Francesco La Vigna, Stefano Lo Russo, Adele Manzella, Roberto Mazza, Maurizio Polemio, Andrea Sottani

ECOTER CPA Srl, LODI, ITALY
paolo.cerutti@ecotercpa.it, info@iahitaly.it

Considering the increasing interest in the use of geothermal resources in Italy in the last decade, as well as the key role hydrogeology plays in the study of geothermal systems and design of installations, within the framework of activities aimed at studying current and future exploitation and the related sustainability of geothermal resources and within the IAH (International Association of Hydrogeologists) Italian Chapter, the Working Group IDROGEOTER was set up in October 2012 and started operating in February 2013.

With regard to the workplan of the Working Group, the first step is an analysis of the state of the art in the current use of low-to-high enthalpy geothermal resources in Italy; this will be achieved through an inventory of data, applications and case studies, aimed at determining the relationship between the hydrogeological settings resulting from features such as hydrostratigraphy, hydraulic and hydrodynamic conditions, hydrogeochemistry, and the availability of the resource and the potential of the systems; a further development will form part of the activities of IDROGEOTER, corresponding to the preparation of a proposal of guidelines, specifically focused on sustainability, for hydro-geothermal studies.

Whatever the type of geothermal system, groundwater plays a key role in the study of geothermal installations. The hydrogeological characteristics, such as the piezometric pattern, the recharge mechanism, hydraulic parameters, hydrodynamic conditions and hydrochemical features, influence the availability of the resource in terms of temperature, amount and quality. Detailed hydrogeological studies, carried out in Italy (Figure 1) in order to optimize the use of geothermal resources, regarding different enthalpy levels and various geological environments (volcanic, carbonate rock aquifers,….), are described.



In the Lombardy Region (N Italy), currently the most populated and industrialized region in Italy and therefore the area where the highest number of Groundwater Heat-Pump (GW-HP) plants are installed, a representative sample of both open-loop and closed-loop systems could be selected, considering the need to identify the critical hydrogeological factors contributing both to the geothermal potential and to a sustainable use of the resource in the current trend of urban sprawl.

In the Piedmont Region (NW Italy) several experimental sites have been investigated in order to assess the potential subsurface effects of open-loop GW-HP plants for the cooling and heating of buildings; a comparison between field measures and numerical modelling results reveals that the most important aquifer parameters affecting the developing of the Thermal Affected Zone (TAZ) around the injection wells are those related to advective heat transfer.

In the Veneto Region (NE Italy), with regard to high enthalpy, the Euganean Geothermal Field (EGF) is the most important thermal field in northern Italy. At present about 250 wells are active (flow rate = 17 Mm3/y) and the thermal waters

(temperature = 65-86 °C) are mainly used for spas; recently, a new conceptual model of the Euganean Geothermal System (EGS) has been proposed: the waters are of meteoric origin, infiltrate 80 Km to the north of the EGF in the pre-Alps, flow to the south in a Mesozoic carbonate reservoir, reach a depth of about 3000 m and warm up by a normal geothermal gradient; the conceptual model is tested in a numerical model.

In other areas of the Veneto Region and with regard to low enthalpy, other studies are in progress on sites potentially suitable for closed-loop and open-loop systems, and together with data from automated monitoring of several wells, these could be used for advanced analysis of different hydro-geothermal systems; advanced analyses have been carried out at the pilot site of Vicenza, to characterize different hydro-geothermal systems. The design of the GCHP system, combining a heat pump with a ground heat exchanger (closed loop systems), was authorized temporarily, until the results of the monitoring phase become available; these results may be useful for completing in particular the hydrogeological and environmental assessment and achieving a more specific knowledge of the local application for a vertical closed loop heat exchanger system, which in the studied area is marked by the presence of excellent aquifers, in terms of both qualitative features and quantitative peculiarities.

Research activities in the Lazio Region (Central Italy) also focus on low enthalpy and are specifically aimed at two main objectives: at a regional scale, and together with the local regional administration, the mapping of the geothermal potential of aquifers, and at a more local scale, pilot studies of sites located in Rome and characterized by gravel aquifers, alluvial Holocene deposits of the Tevere River and alluvial pre-volcanic Pleistocene deposits.

In the Campania, Apulia and Sicily Regions (S Italy), in the framework of the geothermal exploration programme known as "VIGOR" (Evaluation of Geothermal Potential in Convergence Region), hydrogeological characterization has proved very important for geothermal assessment and together with other data has been used to produce local and regional geothermal assessments. Some examples are shown on a regional (Sicily Region) and local scale (Campania Region). In the latter case, in the Mondragone area, a groundwater balance, verifying the recharge area of thermal springs (temperature 33-54 °C) connected to a large carbonate aquifer, has permitted the identification of the most suitable area in which to drill a geothermal well. In the Apulian case of the Santa Cesarea coastal springs (temperature 23-28 °C) the thermal field trend consequent to groundwater advection and the influence of seawater intrusion for two karstic coastal aquifers (Murgia and Salento) at various elevations between -5 and -100 m amsl was reconstructed and the maximum temperature of deep groundwater assessed. These analyses are intended to provide required basic knowledge for correctly implementing low enthalpy Heat-Pump plants in the saturated zone.