

## Geothermal development in southern Italy and the contribution of the ATLANTE GEOTERMICO Project

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### ABSTRACT

The Atlante Geotermico (Geothermal Atlas) is a project aimed at assessing conventional and unconventional geothermal resources for power production in southern Italy.

The projects refers to nine regions, and is related to medium-high temperature resources for power production, providing maps related to the distribution and favourability of territories to host hydrothermal systems, as wells as EGS, magmatic, supercritical and geopressurized conditions.

The projects aims also to test remote sensing techniques for geothermal exploration and for investigating and monitoring environmental impact of geothermal exploitation. It foresees the establishment of a data centre for providing public information of the underground conditions.

Results will be useful for planning and development of geothermal power production on a regional and national level, and also for establishing suitable locations and characteristics of research and demonstration projects.

### 1. MAIN AIMS AND DEVELOPMENT

Energy from geothermal resources plays an increasing role in many countries in their efforts to increase the proportion of renewables in their energy portfolio. The technologies exploiting geothermal heat have a high load factor, are sustainable and environmentally friendly.

Italy is a geothermal country: the fifth geothermal power producer in the world, a large quantity of direct uses of geothermal uses, and the first example in the world of geothermal production at industrial scale. Indeed, geothermal energy is seldom considered in the energy planning at national and regional levels, and although it would require specific incentives and regulation, it may count only on generalized (and reducing) incentives for renewable energies. New geothermal projects, both for demonstration and for research, are finding many difficulties in their establishment.

Many issues are the reasons of this situation, but we think that the expansion of geothermal energy, to increase the number of projects as well as the variety of uses, requires a number of steps:

- A comprehensive identification of resources and opportunities, as well as an accessible collection of data and information
- The promotion and dissemination of technology, values, economics, as well as a dedicated effort for improving social awareness and acceptance of geothermal energy
- Research and technological development
- A clear and easy to follow regulation for authorizations in the exploration, drilling and exploitation phases of the project

The National Research Council (CNR), which has worked in geothermal assessment of Italian geothermal resources since the '70s and has been the main reference for the research in this energy field for many decades, has offered the opportunity to promote the development of geothermal energy in Italy by producing an advanced tool for targeting the first two of the above mentioned requirements, for the moment focused on southern Italy, while pursuing the technological developments in other various, often international, projects.

The Atlante Geotermico del Mezzogiorno d'Italia (Geothermal Atlas of southern Italy) Project has been conceived on the notation that nowadays the assessment of the available geothermal resources and potential is not homogeneous in the Italian territories, is not completely systematized in a single database, and is also out of date in relation to advances in technology. The project is funded by CNR and focused on the characterization, classification and imaging of conventional and non-conventional resources of southern Italy for power production.

The Geothermal Atlas aims at organizing underground data and mapping the distribution of known hydrothermal systems as well as potential Unconventional Geothermal systems (supercritical and magmatic systems, high concentration of heat at

medium depth which could be exploited with EGS technological development). It is related to medium-high temperature resources and power production, and foresees the establishment of data centres for providing public information of the underground conditions. Environmental issues, including public acceptance are also taken into account.

Besides improving the probability of finding an unknown hydrothermal system, the Atlante assessment establishes a more detailed resources reporting system to provide the basis for portfolio management of conventional geothermal resources. Moreover, emerging activities to harness energy from Unconventional Geothermal Systems, such as supercritical reservoirs or from improving permeability in hot hydrothermal systems (EGS), would make significant progress with qualified input from research. Atlante, therefore, targets resources by selecting and proposing specific locations for development of both demonstration and research projects by using actual or advanced technology, respectively.

The core of the project is the organization of geothermal information, both as maps of favourable condition to the presence of various kinds of geothermal resources, and as an organized information system able not only to store and provide information, but also to update, integrate and combine data following a scheme for favourability assessment.

The most relevant existing information regarding geothermal potential is temperature data from oil and gas exploration boreholes and physical and chemical information from natural thermal springs. At the beginning of the project, available geothermal data consisted of the characterization performed in the '80s in the frame of the last inventory of geothermal resources, which is collected in the National Geothermal Database, managed by the CNR. The database has been recently updated with information from oil and gas boreholes liberalized and provided by the Ministry of Economic Development. However, this kind of data refers only to a minor part of the territory. Other indirect information in areas lacking boreholes and springs comes from geological, geochemical and geophysical surveys. These useful, but fragmented, information regarding underground conditions may be retrieved in public reports, scientific papers, and other underground databases established for various uses. The VIGOR Project (Manzella and VIGOR Team, 2013) has provided a first occasion to collect and organize data useful for a regional assessment of the geothermal potential in four of the nine regions of Atlante. These data have been used in Atlante, however the database has been extended to include not only the other five regions, but also other various information in consideration of the different targets of the two projects. In Atlante we consider all possible indication of deep fluid circulation, thermal anomalies and heat sources at depth, as well as other favourable condition for power

production such as high pressure condition in hot sedimentary aquifers or stress condition for EGS stimulation.

In the resource assessment Atlante takes into account the recently published protocol of GEO-ELEC Project (van Wees et al., 2013). Following to the classification established in the protocol, the Atlante Project focus on the identification of potential "plays", i.e., of "geographically (and in depth) delimited areas where specific subsurface conditions allow to obtain sufficiently high flow rate of sufficiently high temperature, with suitable pressure and chemical conditions". However, instead of considering and distinguishing the Magmatic, Hot Sedimentary and Hot Rock Plays considered in the protocol, in the Atlante Geotermico we distinguish and assess favourable underground condition for 1) hydrothermal resources, i.e., naturally convective systems, 2) EGS including HDR and HWR conditions suitable for stimulation, 3) magmatic, supersaline and supercritical systems associated to volcanic areas, 4) geopressurized systems and systems for co-production of geothermal fluids and hydrocarbons in sedimentary rocks.

After mapping well and spring location and their associated info, the following step for the assessment is the determination of the spatial association between geological, geochemical and geophysical evidence and potential production zones. Surface observations are used to delineate areas characterized by high permeability and hot fluid transport from the reservoir: main faults, superficial fracture density, surface manifestations, and geochemical and geophysical anomalies. Various knowledge-driven models are constructed based on a conceptual model of the systems, and probability (e.g., Boolean, Index Overlay and Fuzzy scheme) models are tested to verify if they show a good correlation with the location of known geothermal systems, in order to produce a useful scheme for planning further detailed exploration in undiscovered but potentially important geothermal systems.

Data organization is guaranteed by the establishment of a Geothermal Information Platform (GIP), as described in Trumphy et al., 2013. The organization of a Data Centre is foreseen as one of the main product of the project, providing information to different kind of stakeholders, from general public to administration and government, as well as operators, interested in understanding future perspectives of geothermal development.

The Data Center will provide also the other information related to the geothermal development that are tackled in Atlante, in particular the environmental aspects and social acceptance. Reports regarding these two topics and an environmental study in Ischia island and Mondragone area are under development.

The project is also the occasion for sharing knowledge, both among the participants of the project coming from nine different institutes of CNR and with other stakeholders. The dissemination and promotion takes the form of seminars, Schools, Workshops, Mobility actions and the organization of communication tools such as a project website including the Data Portal, and the preparation of documents to be diffused through the main communication systems, e.g., scientific and general publications in journals, magazine and newspapers.

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