In this study, the overall reservoir/caprock system structural-stratigraphic setting has been defined based on the integrated interpretation of surface geology, public and available seismic reflection profiles, and composite well logs. In particular, a careful assessment of temperature field at depth has been carried out analyzing well logs through Horner plot construction. Where the data were scarce, a simplified approach has been applied. Moreover, based on well tests, cores and losses/absorptions the reservoir permeability was also re-estimated, confirming quite good permeability value for the fractured carbonate reservoir.
One of the main results of this research is the development of an integrated 3D geological model which provides the base for a detailed assessment of the possible geothermal exploitation of the carbonate reservoir. The preliminary results of our analysis suggest that the "Guardia dei Lombardi" site can be indicated as an interesting area for the geothermal medium enthalpy exploitation, although the presence of the CO2 gas cap should be carefully evaluated.

D9-11 Poster Bruno, Delia Evelina

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THE DEFINITION OF REGULATIONS AND TRANSPARENT PROCEDURES FOR AUTHORIZATIONS TO PROMOTE THE LOW ENTHALPY GEOTHERMAL: THE VIGOR PROJECT'S CONTRIBUTION

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Key terms: environmental regulations; geological survey; aquifer; map; hydrothermal

Today, in the "Convergence Regions" (Puglia, Campania, Calabria, Sicilia) the amount of energy produced by geothermal resources is still negligible, despite the exciting opportunities to exploit even in the less significant geothermal potential areas, with considerable economy for the air-conditioned and the hot-water production. The "Vigor: evaluation of geothermal potential" project was started as from October 2010 with 24 months of life. The project's objectives are related to examination, identification and dissemination of all scientific and technical informations concerning the evaluation of geothermal potential in the Convergence Regions. Moreover, it aims to promote the optimum conditions in terms of regulations and administrative practices.
In fact, one of its objectives is to support the balanced development of the environmental compartment, preventing deficiencies and asymmetries with particular reference to other renewable resources affected by an initial legislation's delay. Therefore one of the activities is the informations collection of the bureaucratic procedures related to exploration and exploitation of geothermal resources in the four regions. Currently, while the plants for electric energy by renewable resources receive constant attention by the legislature, the geothermal potential exploitation is indirectly treated only. So, this research with connected applications, from the legal point of view, could incur into bureaucratic obstacles avoiding difficulties of interpretation.
Hence, the first step for these activities involved a review of existing regulations, through the drafting of a questionnaire submitted to the Regions offices. The evidences examination for the best regulative practices at national and international levels, with the informations described and discussed in the context analysis, will make certain assumptions of guidelines, protocols and authorizations of regulative instruments. The normatives uniformity will be evaluated and discussed with the scientific support of all researchers involved in VIGOR.

D9-12 Poster Caputo, Maria Clementina

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HYDROGEOLOGICAL CHARACTERIZATION OF A COASTAL AREA AIMED AT THE EXPLOITATION OF LOW ENTHALPY GEOTHERMAL RESOURCES

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Key terms: hydrological characterization; geothermal resource; low entalpy

The interest in low enthalpy geothermal energy is growing in Italy in last years because the geothermal energy represents an important resource among the different kinds of green energies. However the exploitation of the geothermal resources concerns many issues related its environmental sustainability.
Particularly, the matter involves the open loop geothermal systems because of their direct use of groundwater. In the coastal areas, generally characterized by shallow aquifer, the installation of the geothermal systems is considered economically convenient because it doesn't need deep boreholes. Despite this positive aspect there are others negative ones also. Often these areas are affected by seawater intrusion and for this reason; the use of the coastal aquifer is ruled by restrictive laws aimed to protect the groundwater quality and quantity. This is a major problem for geothermal resources development, particularly in regions characterized for most of their territory from coasts. However, as the most of the population, the most important touristic destinations and the larger industrial sites are concentrated along the coast, the exploitation of geothermal resource in these areas is becoming more and more of interest.
This work deals with a hydrogeological characterization by means field tests and experimental measurements carried out in a costal karst area of Apulia Region, located about 2 km far from the sea. Specifically, the study area extends for about 20 Km2 and has been chosen within the VIGOR project as pilot site to study the influence of an open loop geothermal systems, on the sea water intrusion.
In the study area different tests, such as pumping tests, have been carried out in different times in order to determine the aquifer transmissivity; a wells monitoring network has been defined to monitor the depth and the hydraulic gradient of groundwater and its salinity and temperature.
All the data (geological, hydrogeological, geochemical and geophysical) and information collected during the exploration phase, allowed a detailed characterization of the fissured-karst aquifer.
The experimental approach utilized for this study represents a good effort to define a standard methodology, for hydraulic characterization of a coastal site, usefull for a feasibility study of an open loop geothermal system.

D9-13 Poster Petruccione, Emanuela

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A PRELIMINARY GEOTHERMAL EVALUATION OF THE MONDRAGONE AREA (CAMPANIAN PLAIN, SOUTHERN ITALY) IN THE FRAME OF THE VIGOR PROJECT

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Key terms: Campania Region; Geothermal Exploration; Geothermal Resource Assessment

An organic organization and implementation of the available geothermal data in the southern Italian Regions (Campania, Calabria, Puglia and Sicily) useful to improve the exploration and exploitation of geothermal reservoirs, is the aim of the CNR project "Evaluation of Geothermal Potential in Convergence Regions" (VIGOR), financed by the Inter-Regional Operational Programme "Renewable Energy and Energy Conservation" POI 2007-2013.
In the Mondragone area hydrothermal evidences has been known since roman time, and this area has been chosen to further improve geothermal knowledge through new geophysical and geological exploration survey. From the geological point of view, the area is defined by an horst structure (Mt. Massico) elongate in NE-SW direction, characterized by a succession of Triassic-Cretaceous dolomitic limestone and Miocene terrigenous sediments. The Quaternary deposits are widespread in the adjacent plains , where the continental and marine sediments, interbedded with Roccamonfina and Campi Flegrei pyroclastic deposits, filling the Garigliano, to NW, and Volturno, to SE, graben, separated by the Mt Massico horst throught a NE-SW striking normal faults (Bergomi et al., 1969).
Field and seismic data indicate the study area is interested by deep normal NE-SW and N-S striking faults, although ESE-WNW to E-W strike-slip left-lateral faults are also present (Billi et al., 1997; Bruno et al., 2000). Probably these structural pattern plays an important role for the Mt. Massico groundwater circolation, partially confining such structure from the less permeable deposits of plains, and allowing the groundwater to flow primarily to the aquifer of the Garigliano plain (Allocca et al., 2005).
At the southeastern edge of the massif four sulfur hot springs with temperatures between 22°C and 50°C emerge. In particular two hot springs, ("La Calda" and "Della Salute", up to 50°C and 29°C respectively) are located at the foothill of the Miocene terrigenous succession of Mt. Pizzuto, closely to the coast (Bergomi et al., 1969, Corniello, 1988). While the other two ("S. Giuseppe" and "Mt. Petrino solforosa" up to 22°C and 28°C respectively) are located at the foothill of the Mt. Petrino carbonatic structure (Trumpy & Manzella, 2009).
According to some authors, the hot springs are fed by groundwater carbonate aquifer, where the water is heated and enriched of endogenous gas (CO_2, H_2S), rising along the extensive and deep tectonic discontinuity present, further testified by the morphological evidenced (sinkholes) found all along the southeastern edge of the Mt Massico (Del Prete et al., 2004). Moreover the different temperatures and degrees of mineralization of the four springs are interpreted as closely linked to the rising speed and water-rock contact time (Corniello, 1988; Allocca et al., 2005).
A delimited area of 20 km^2 south-east of Mt. Massico has been chosen to be studied by means of geological and geophysical surveys and deep drilling to provide analytical information useful to develop an hydrogeological 3D model that will allows the application of technologies for direct explotation of heat from geothermal source.

D9-14 Poster Carlino, Stefano

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THE GEOTHERMAL POTENTIAL OF CAMPANIA VOLCANOES.

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Key terms: Geothermics; Volcanoes; Campi Flegrei; Ischia

Since 1939, many drilling finalized to the exploitation of the geothermal energy, were performed in volcanic district of Campania (Campi Flegrei, Ischia and Vesuvius), by SAFEN Company and subsequently, until 1985, by AGIP-ENEL joint venture. The attention to the geothermal energy exploration in Southern Italy was drawn by either the consolidate energy production of Larderello geothermal field (Tuscany) and by the oil crisis during the mid seventies. The results of the drilling were particularly interesting at Campi Flegrei and Ischia, where the high temperature (> 150°C) recorded at shallow depth (500 to 2000 m) and the occurrence of vigorous hot hydrothermal circulation, highlighted the possibility of geothermal exploitation also in the high enthalpy range. The project was abandoned at the end of 1970, probably due to technical problems related to the extraction of high salinity geothermal fluids, but also because the Italian Government preferred to comply with the oil economy. Nowadays, the advanced technology of geothermal plants (i.e. binary system) allows the solving of problems related to such harsh conditions.
The data obtained by drilling (down to 3 km of depth) and investigation between 1939 and 1985 allowed us to asses, by using the volume method, the geothermal resource for Campi Flegrei and Ischia, which correspond to a potential energy of about 6 and 11 GWy respectively. Such high values, together with the nowadays strong oil cost fluctuation and green energy policies, point out the needs to better define the actual possibility of geothermal exploitation in Campania volcanic district. In recent times, an important project (Campi Flegrei Deep Drilling Project, CFDDP) endorsed by the International Continental Drilling Program, is aimed to the understanding of the Campi Flegrei caldera dynamic and evaluate of the extractable geothermal resource, by two drillings located in the eastern sector of the caldera, the first (pilot hole) 500 m depth and

the second 3.5 km depth . The CFDDP will greatly improve scientific information of the eruptive history of the Campi Flegrei caldera, and knowledge of the related geothermal system. Thus, the project will represent a new starting point for the exploitation of geothermal resource in Southern Italy, where many areas are characterised by the presence of deep to shallow magma bodies, with high geothermal potential.

D9-15 Poster Giambastiani, Beatrice Maria Sole

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GEO.POWER: A PROJECT TO MANAGE THE GROWING DEMAND OF LOW-ENTHALPY GEOTHERMAL EXPLOITATION

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Key terms: Geothermal Energy; Renewable Energy Source; Ground-Coupled Heat Pump; Best Practice; Transferability

The European Union is committed to reducing its own greenhouse gas emissions by at least 20% by 2020 (compared with 1990 levels) by improving the use of renewable energy and decreasing energy consumption. Thus, the Commission in the Renewable Energy Road Map encourages the Member States and their local authorities to implement concrete measures within regional operational programmes in order to improve the yield of energy production and distribution, to facilitate investments in the green sector, and to encourage rational energy consumption behaviour.
Geothermal energy is one of the most environmental-friendly and cost-effective energy resources in use. Recent technological progress, cost variability, and the need to reduce the use of fossil fuels to cut pollution have made the exploitation of geothermal energy, especially low-enthalpy power generation utilizing Ground-Coupled Heat Pumps (GCHP), a feasible alternative. In this context, the GEO.POWER partners developed a project on geothermal energy, under the INTERREG IVC Programme, to fill their legislation gaps and in that way actively contribute to the EU "20-20-20" objective.
The general objective of the 2 year GEO.POWER project ("Geothermal energy to address energy performance strategies in residential and industrial buildings" http://geopower-i4c.eu/) is exchange best practices (BPs) related to low enthalpy energy supply and - after a technical and cost/benefit assessment to evaluate the potential of reproducibility - to prepare the ground to the transfer some of the selected best practices within the Mainstreaming Programmes of the regions participating into the project.
The partnership, coordinated by the Province of Ferrara (Italy) is composed by Ministries, Regions, Local Authorities, Universities of 9 Countries (Bulgaria, Hungary, Greece, Italy, Sweden, Estonia, Slovenia, United Kingdom and Belgium).
The project is basically divided in three phases:
° Phase 1 (January-May 2011) regards a review of the BPs achieved within GCHP sector and their possible application for the sustainable heating/cooling technology. Expertises are shared and exchanged within the partners and local deep delegations (composed by energy managers, technicians, stakeholders, urban planners, etc.) through the preparation of benchmarking reports and workshops.
° Phase 2 (July-December 2011) is based on an assessment for the reproducibility of the selected BPs in each recipient region. In this phase all partners go through a local technical analysis to estimate the weakness and potentialities for the application/adaptation of the identified GCHP practises in their own areas. This phase is addressed to design the optimum performance conditions for GCHP systems in terms of technical, economical and environmental point of view.
° Phase 3 (January-June 2012) consists in the elaboration of an action plan for each involved region to support policymakers' commitment. The action plan paves the way towards the transferability of the (adapted) BPs into the Mainstreaming Programmes and energy regulations plans.
The main results of the project are the development of one action plan per each involved region, that provides an organized set of legal/regulatory, economical, and technical proposals. These proposals will include the regional operation programmes and address long-term investments strategy for GCHP application at wide scale. The project is still ongoing but preliminary results are now available (http://geopower-i4c.eu/index.php?page=bpview) consisting in a selection of best practices. Out of the 31 BPs initially screened, 12 BPs have been selected (4 in the public, 4 in the industry, 3 in private and 1 in the agriculture sector) according to the following criteria: field of application; type of systems; different hydrogeological setting; type of building; efficiency parameters; quality of the monitoring scheme; integration with other RES; benefits and level of supposed transferability.

D9-16 Poster Quarantini, Mattia

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GEOLOGY AND HYDROGEOLOGY IN THE GEOTHERMAL HEAT EXCHANGER

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Key terms: Geothermal energy; Geothermal heat exchanger; Hydrogeological properties

The correct design and performance of geothermal heat exchanger coupled with heat pump systems requires knowledge of the thermal proprieties of the subsurface rocks where the geology and especially the hydrogeology, play an important role. The accurate prediction of transient ground heat transfer is the key to establish the required borehole length and to determine the resulting fluid temperature. Moreover a correct dimensioning of geothermal heat exchanger system is essential for ensuring the sustainability of this technology.
The ground thermal proprieties can be measured in situ with a thermal response tests (TRT) where a heat transfer fluid flowing in a ground heat exchanger is heated and the resulting temperature perturbation is monitored. This method is largely approved in different countries for to determinate the thermal conductivity and the thermal resistance of the whole borehole.
The vertical ground thermal property variations inside the borehole during a TRT and the resulting cooling after the test, allows correlating the subsurface thermal conductivity with stratigraphy. The logs of the evolution of the temperature recovery, combined with the hydrogeological data permit to discriminate the thermal exchange of each discrete layers. This methodology permits to obtain a distribute vertical thermal conductivity and thermal resistance of the subsoil and provide an useful tool for a correct dimensioning of boreholes number, depth, spacing and geometrical arrays, take in account the entire heating and cooling seasonal cycle of the system.

D9-17 Poster Stringari, Marco

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EVALUATION OF THERMAL DISTURBANCE IN SHALLOW AQUIFER INDUCED BY OPEN-LOOP GEOTHERMAL PLANTS

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Key terms: Open-loop geothermal plants; Thermal alteration; Numerical model

Among the various systems of heat exchange with the subsurface it is possible to directly take the heat stored in the groundwater through the use of open-loop geothermal systems. The water is pumped to the surface through one or more wells and then it is generally pumped back into the groundwater (heated or cooled by the plant) through other wells.
The study of the thermal plume generated by the injection of heated or cooled water in the aquifer is very important. The study of propagation of the plume allows to assess the sustainability of the system in terms of heat and it avoids the possible influence / interference with existing plants and the involvement of sensitive areas such as wells for drinking water and rivers.
The thermal characteristics of the aquifer and the re-injection water temperature determine the intensity of the induced thermal disturbance. Hydrogeological characteristics of the area determine the extent of the thermal plume.
An aquifer is composed of a porous media, that is a solid matrix with interstitial spaces and water. The main hydro-geological characteristics that determine the groundwater flow (and the thermal propagation) are the hydraulic conductivity, the specific yield, the hydraulic gradient and the longitudinal dispersivity.
The finite-difference groundwater flow and transport code SEAWAT was used to realize numerical models, representing thermal plumes in typical hydrogeological conditions of Piemonte region. Specifically, the thermal effect caused by the re-injection of hot/cool water in the shallow aquifer was simulated.
SEAWAT is a MODFLOW/MT3DMS-based code designed to simulate three-dimensional variable-density groundwater flow coupled with multi-species solute and heat transport.
The simulations were made varying pumping rates in contexts characterized by different hydrological parameters. For each parametric variation was carried out a simulation and the possible propagation of the thermal plume was identified. The range of used hydrogeological parameters are typical of the aquifers of the Po river plain (Pianura Padana) and especially of the Piemonte plain.
The simulations were carried out in permanent regime, assuming either a continuous or intermittent operation of the system, in eating and cooling mode.

The choice of the "ΔT" parameter (the difference between the extraction and re-injection temperature from the groundwater) was based on temperature differences commonly founded in real plants, about 5 °C.
The natural temperatures of shallow aquifer are fairly constant during the year and they generally are between 13 and 16 °C in most of Piemonte plain. Seasonal variations usually oscillate around 1 °C. Since the goal of the survey was not the study of absolute temperature of the thermal plume, but the thermal variations in the aquifer, the undisturbed temperature in the simulations was considered constant and equal to an average value of 14,5 °C.
Comparing the different thermal plumes, it was possible to identify how different hydrogeological characteristics of an aquifer contribute to the expansion of the thermal plume.
For example it resulted that, under the same hydrogeological characteristics, the extent and intensity of the thermal plume increased significantly with increasing pumping rates of re-injection into groundwater. Dividing the same pumping rate between adjacent wells, the extent of the single plume decreases, but the thermal effects of individual wells may be combined with each other.
At constant pumping rates, the temperature changes and lateral extent of the plume are larger the lower the rate of groundwater flow. In the case of intermittent operation of the system, the time required for the disappearance of the plume is also inversely proportional to the groundwater flow.

D9-18 Poster Verdoya, Massimo

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PROCESSING OF THERMAL RESPONSE TESTS AND UNDERGROUND TEMPERATURE DATA IN BOREHOLE HEAT EXCHANGERS

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Key terms: Geothermal energy; low enthalpy; thermal conductivity

The use of geothermal heat pumps (GHPs) has been rapidly spreading in many countries, as a clean and efficient system for heating and cooling commercial and residential buildings. A typical GHP system mainly consists of a conventional heat pump unit coupled with a group of drillholes, which act as heat exchangers (BHEs). The thermal power that can be extracted with a BHE is site-specific and depends mainly on the thermal properties of the underground, and in particular, on the thermal conductivity. Laboratory measurements on thermophysical properties can be unfeasible as core samples are often unavailable in commercial holes. Thus, an in situ thermal response test (TRT) is carried out as an alternative investigation to obtain the actual heat-transfer performance between the underground and a BHE, as well as the ground thermal properties.
TRT experiment records the inlet and outlet temperature of a closed loop in a ready-to-operate BHE due to constant heating or cooling by the fluid