under the funding program

Horizon 2020

GEOTHERMAL ENERGY

Project acronym:

DESCRAMBLE

Drilling in dEep, Super-CRitical AMBient of continentaL Europe

Authors:

A. Manzella, E. Trumpy, R. Bertani

done in Pisa on:

Thursday, October 27, 2016

Grant agreement reference: /640573/"DESCRAMBLE"/LCE-2-2014/2015

Project duration: 01.05.2015 ÷ 30.04.2018

Project total cost: 15.615.955 €
EU contribution: 6.753.635€

Coordinating entity: ENEL GREEN POWER (EGP)
Via Andrea Pisano 120 – 56122 Pisa - Italy
Coordinator: Dr. Ruggero Bertani
Tel.: 0039–0506185650 email: ruggero.bertani@enel.com

Project web site: http://www.descramble-h2020.eu

1. SUMMARY

The "**D**rilling in d**E**ep, **S**uper-**CR**itical **AMB**ient of continenta**L** **E**urope" (**DESCRAMBLE**) project is meant to drill in continental-crust, super-critical geothermal conditions, to test and demonstrate novel drilling techniques to control gas emissions, the aggressive environment and the high temperature/pressure expected from the deep fluids and to characterize the chemical and thermo-physical condition of the reservoir. The experiment is realized in Larderello, Italy, where supercritical resources are expected within a depth of 4 km.

Following the project structure, the activities focussed on two main goals: preparation for drilling in supercritical condition and the understanding of deep geological condition for predicting and controlling critical conditions. In relation to drilling, the partners produced a preliminary well design, procured all the necessary drilling materials and prepared the well pad. A new high temperature and pressure (up to 450°C, 450 bar) logging tool, has been designed, built and preliminarily tested. New data have been acquired in the experiment area to achieve a more refined understanding of local and deep condition: active seismic surveys (VSP and Piggy Back), as add on to previous data, and passive seismic data obtained by the increased the station density of the local micro-seismic network. Data were analysed, integrated and interpreted for defining the drilling target. A preliminary set of well logs in the already accessible portion of the well has been acquired and provided further information for geophysical data analyses and modelling.

Regional and local 3D geological and thermodynamic models have been built and tested, and are continuously updated with the latest information. Rock and fluid sample were collected for laboratory analysis, which is providing further insight of deep geological, geochemical and geophysical condition.

The activity is supported by internal information and dissemination activity, including knowledge exchange with developer of similar projects through web-conference and meetings.

2. PROJECT SCOPE

DESCRAMBLE's scope is the development of new drilling technologies and concepts for geothermal energy exploitation from deep and super-critical geothermal resources in continental geological condition in Europe and its testing. DESCRAMBLE's specific objectives are:

- Demonstrate safe drilling of a deep super-critical geothermal well.
- Reduce the technical and financial risks of drilling and exploiting deep geothermal wells by improving knowledge of the physical and chemical conditions in deep geothermal formations.
- Reduce pre-drill uncertainty in the exploration of deep geothermal wells by applying the latest seismic processing, imaging and interpretation technology for exploring the supercritical reservoir prior to drilling.
- Investigate the economic potential of exploiting chemicals and minerals by analysing fluid samples for valuable materials.

3. PROJECT TECHNICAL DESCRIPTION & IMPLEMENTATION

To achieve DESCRAMBLE's scope, the first drilling in the world in an intra-continental site at a middle-crustal level will be performed, in order to test and demonstrate novel drilling techniques to control gas emissions, the aggressive environment and the high temperature/pressure expected from the deep fluids. Moreover, the project will improve knowledge of deep chemical-physical conditions for predicting and controlling critical drilling conditions by performing rock and fluid analyses and numerical physico-chemical simulation of the area.

4. RESULTS ACHIEVED

Currently the project, which reached month #18, has achieved the following main outcomes:

- The realization of the project website (www.descramble-h2020.eu) including a private area realized with a Virtual Research Environment (VRE) acting as data repository and information exchange within the project consortium, and the implementation of the Data Management Plan (DMP).
- A Web Project Conference to share the information and lesson learned from similar projects, i.e., Japan (JBBP) and Iceland (IDDP2). The follow-up of the web conference was a physical meeting, held in Larderello on the 3-4 of February 2016.
- The implementation of regional and local simulation model with available data (figure 1).
- The upgrading of the seismic network by installing 4 new micro-seismic stations.
- The completion of VSP and Piggy Back Experiment (figure 2) aimed at the determination of the velocity structure in the shallow subsurface, and the investigations of the deep structures by modelling the recorded seismic signals. Deep drilling target through data integration has been defined.

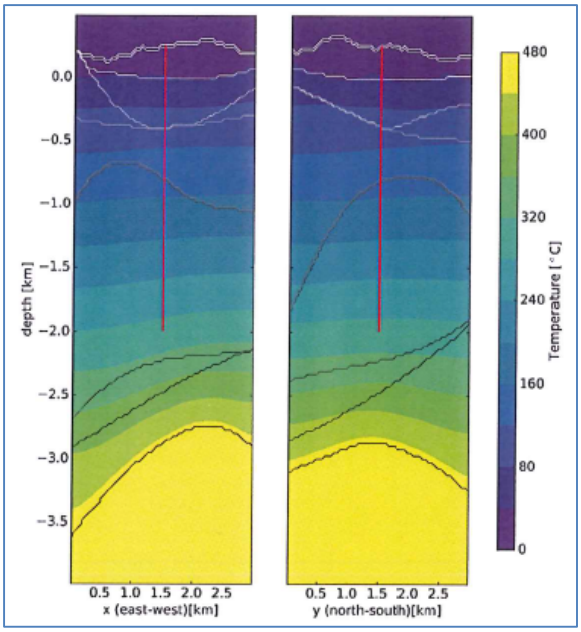

Figure 1 – An example of local model under study

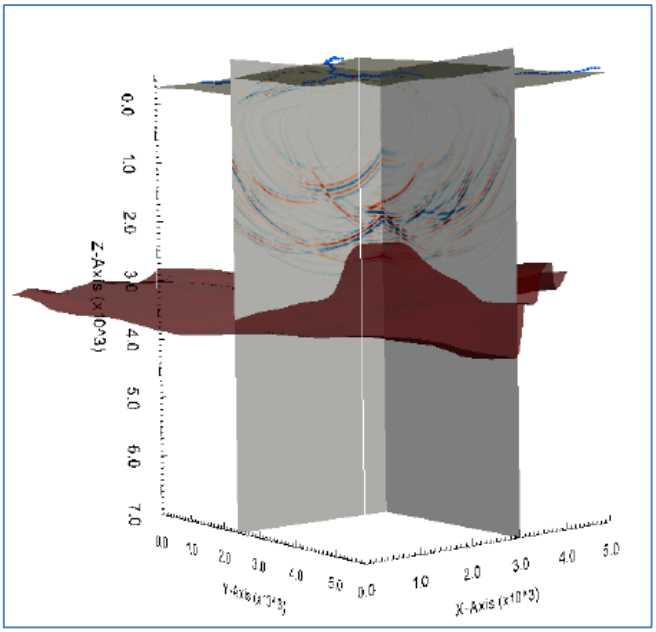

Figure 2 – Piggy Back imaging results

- The preliminary well logs at depth of 1596 m in the Venelle_2 well were carried out. In particular: HDIL (High Definition Induction log), WGI (Wellbore Geometry Instrument), TTRM (Temperature, Tension and Mud Resistivity sub), UXPL (Ultrasonic Explorer for CBIL Image log), XMAC (X-Multipole Array Acoustic log), FLEX (Formation Lithology eXplorer) and DSL (Digital Spectralog). Data have been analysed and interpreted.
- After the collection of about 20 rock samples from several wells in the metamorphic basement, and chemical fluid sampling from nearby wells, the chemical and mineralogical analyses are providing information related to deep seated chemical and thermodynamic condition. Completion rate of fluid inclusion, predrilling fluid samples and rock samples laboratory analyses are 80%, 70% and 80%, respectively. Fluid samples from two more wells will we collected soon.
- The design and realization of a tool for measuring pressure and temperature in high temperature and pressure conditions (figure 3). The electronic boards have been assembled and the laboratory test has started.
- Detailed well design and the procurement of necessary material are almost completed, and the drilling pad is ready (figure 4).

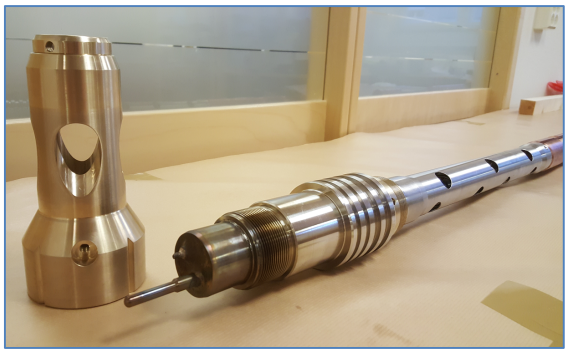

Figure 3 – HT-HP logging tool

Figure 4 – Drilling Pad completed

5. IMPACT

a. Replicability

Actual technologies for geothermal power production are not are directly applicable to supercritical conditions, which are naturally present in the continental crust and generated via deep processes. DESCRAMBLE will open a new segment of the geothermal market in other areas of Europe and abroad.

b. Socio-economic

The DESCRAMBLE consortium, consisting of both European industry and research partners, was selected to ensure a short lead-time from research to innovation, by a) strengthening the European industrial technology base, thereby creating growth and jobs in Europe; b) demonstrating that super-critical wells can be safely drilled with acceptable financial risks; c) improving EU energy security, providing a stable base-load electricity supply where the energy production can be distributed across most of Europe, and reducing dependence on imported energy.

c. Environmental

DESCRAMBLE will reduce life-cycle environmental impact, by building an efficient, compact, closed loop, high capacity power plant, with low land occupation per MWe, and will contribute to solving the global climate and energy challenges by decreasing CO_2 emissions from fossil fuels.

d. Market Transformation

The time-to-market for a geothermal power plant will be reduced from 3-4 years for a standard hydrothermal field down to 2-3 years for a super-critical one.
From a cost perspective, a reduction of 10-15% is expected in comparison with a standard system at the same depth as the super-critical one. This reduction is only due to the 75% reduction of the drilling costs (reducing the number of wells needed), with additional possibility of a further 10% cost abatement due to the learning curve effect. Significantly increased technology performance, by increasing the power output by a factor of 10 compared to existing geothermal plants.
The use of the abundant and free heat as a by-product of the electricity production from a super-critical system could be an important add-on to the economic and environmental aspects of such a project, making it more attractive for investors and for the local population, due to the possibility of accessing (large) district heating and cooling technologies cheaply.

6. ADDITIONAL INFORMATION

The on-going activities, before the drilling phase, are mainly focused on completing testing of the logging tools, the completion of the laboratory determinations on rocks and fluids analysis from nearby wells, and the numerical simulation of thermo-physical deep condition. The outcomes of the DESCRAMBLE project will be exploited through a subsequent project for a first demonstration pilot plant in Larderello.