Novel Productivity Enhancement Concept for a Sustainable Utilization of a Geothermal Resource

Reporting

Project Information

SURE

Grant agreement ID: 654662

Project website

DOI
10.3030/654662

Project closed

EC signature date
21 December 2015

Start date
1 March 2016

End date
31 August 2019

Funded under
SOCIETAL CHALLENGES - Secure, clean and efficient energy

Total cost
€ 6 143 415,00

EU contribution
€ 5 892 165,00

Coordinated by
GFZ HELMHOLTZ-ZENTRUM FUR GEOFORSCHUNG
Germany

This project is featured in...

27 March 2020

Periodic Reporting for period 3 - SURE (Novel Productivity Enhancement Concept for a Sustainable Utilization of a Geothermal Resource)

Reporting period: 2018-03-01 to 2019-08-31

Summary of the context and overall objectives of the project

The global objective of the SURE project was to increase the number of economically viable geothermal wells, and thereby reducing the environmental impact associated with the provision of geothermal energy. Within this project, the radial water jet drilling (RJD) technology was investigated and tested as a stimulation method to increase inflow into insufficiently producing geothermal wells. RJD uses the power of a focused jet of fluids, applied to a reservoir rock in order to create several holes from an existing well about 100 m long into the reservoir at depth (Figure 1). The aim is to drain initially not connected high permeable zones to the main well. The jetting process as well as the controlling parameters were investigated in order to allow for a prediction of the applicability of the jet drilling process in different geological settings as well as an optimization of the siting of such enhanced flow paths around existing wells.
The SURE project contributed to significantly advance the knowledge about the RJD technology beyond the state of the art across different spatial and temporal scales from laboratory to field scale applications bringing it much closer to a successful implementation in the field.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

WP 3 State-of-the-Art:
Within the SURE project, a review of different stimulation technologies to enhance a geothermal system (EGS) was performed. A special focus lied on the benefits and drawbacks of the water jet drilling technology in comparison to the more established stimulation treatments.

WP4 - Micro-Scale Investigation

The physical properties of various potential geothermal reservoir rock types were determined and processes related to the jetting of these rocks were investigated at the laboratory scale. One of the crucial questions addressed was the way in which micro-scale processes, controlling the flow and heat transfer will behave at a larger scale. Therefore, experimental set-ups for the measurement of the jetted laterals stability in the ambient stress field as well as fracture conductivity measurements were established and experiments were performed to analyse the behaviour of various rocks at ambient stress conditions.

WP5 - Meso-Scale Investigation
The objective of this work package was to achieve a most complete understanding of the water jet/tooling-rock-interaction for a large variety of sedimentary and crystalline rocks. Thus, it was necessary a) to prove the existing water jet-technology for different rock characteristics, b) to detect and understand the gaps, c) to improve the design when possible, d) to investigate if additional information about the geological structure is obtainable while drilling and finally e) to iteratively develop an enhanced jetting technology for rock properties that the existing water jet-tooling is not applicable to.
Therefore, a thorough understanding of the physical processes controlling the jet-ability of various rock types was gained through an extensive testing program at a) ambient laboratory conditions with saturated and unsaturated rock samples, b) varying pore pressure conditions, as well as c) true-triaxial stress conditions. In addition, a jetting experiment was performed in a quarry with field scale jetting equipment to bridge the gap between laboratory and field scale conditions. Based on the experiments in this workpackage, improved jet-assisted drilling nozzles were tested and qualified.

WP6 - Macro-Scale Investigation

Based on the knowledge gained from the experiments at the micro (WP4) and meso-scale investigations (WP5), two radial jet drilling stimulations were planned. The aim of the planned field application was to confirm the conclusions drawn from laboratory tests as well as results from the integration work package (WP7). Furthermore, the stimulations were intended to showcase the performance increase for a geothermal well at in-situ conditions in a sedimentary and a magmatic environment, respectively.
Unfortunately, it was not possible to successfully test the RJD stimulation technology. In this framework, however, a workflow was developed to assess and design a RJD stimulation treatment. Based on the field experience, important technical adjustments to the state-of-the-art stimulation technology were investigated. Also, a post-stimulation workflow is proposed and different tools, e.g. a low-cost downhole geophone and a sensor to investigate the lateral's geometry were developed.

WP7 - Integration

In order to enable the operator to evaluate the potential benefit from a RJD stimulation treatment, the experimental results of the previous work packages were numerically analyzed and used to calibrate physical models. As a result, WP7 provides predictive modelling capability to interpret experimental results for WP4-6. These numerical tools can be used to plan and optimize the RJD stimulation design as well as to evaluate the results of a stimulation treatment. As economic aspects are

considered, numerical results can be evaluated in the light of levelized cost of energy.

All results of the SURE project are documented and publicly available. Experimental set-ups and numerical tools were developed and are available for advancing the knowledge about RJD stimulation treatments together with partners in industry and science. A list of the most recent publications can be found on www.sure-h2020.eu.

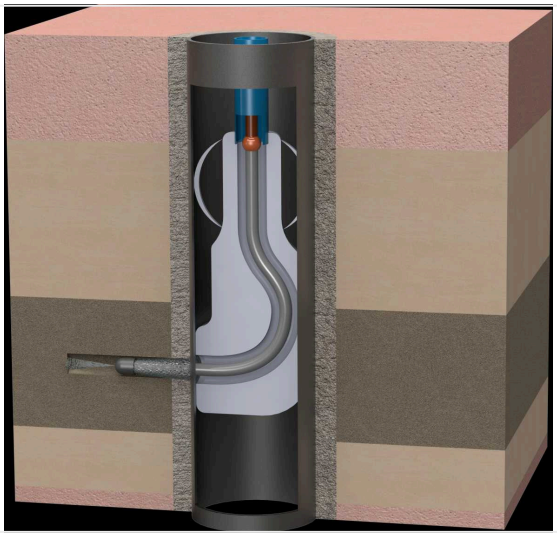
Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

SURE has a significant impact on the development of geothermal systems. Specifically, the impact relates to:

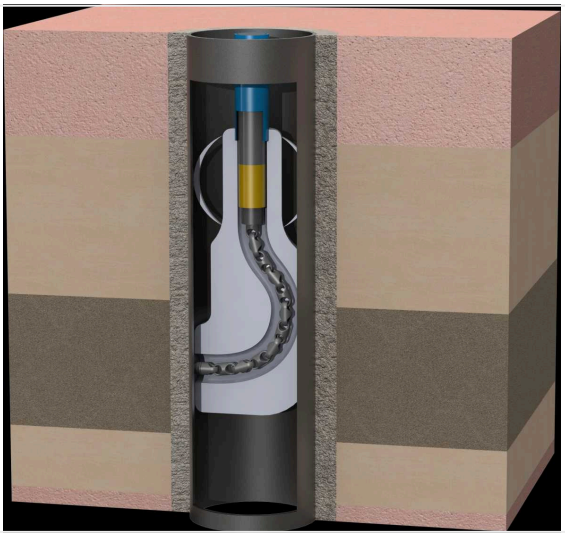
Replicability
By testing the jet-ability of representative reservoir rocks from major geothermal reservoir rock types in Europe, SURE aimed at providing information about the applicability of the RJD technology in different geological settings. Furthermore, an intensive study on the controlling rock physical and operational parameters was performed. Together with the development of numerical simulation tools to evaluate the potential performance increase from RJD stimulation treatments.

Socio-economics
The application of this new stimulation concept for geothermal wells can significantly increase the development of industrial capacity – both for the service industry as well as the geothermal energy companies. Therefore, SURE can contribute to strengthen the European industrial technology base, thereby creating growth and jobs in Europe. Furthermore, the applicability of RJD technology with its inherent very low environmental footprint will increase the societal acceptance of geothermal energy provision.

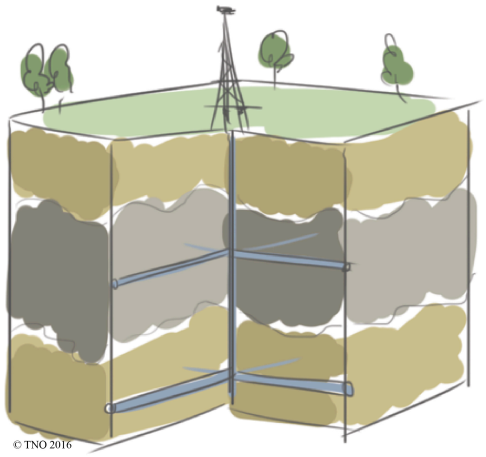
Environment
The proposed technological concept aims to significantly decrease the environmental footprint of a stimulation treatment while reducing simultaneously the amount of applied fluid volumes compared to established stimulation methods, the number of applied chemicals with environmental impact, and the risk of induced seismicity.



Deflector shoe with milling assembly to penetrate the casing downhole (Reinsch & Blöcher, 2017).



Deflector shoe with jetting assembly to jet a laterl into the formation (Reinsch & Blöcher, 2017).



Schematic drawing of the Radial Water Jet Drilling technology.

Last update: 1 April 2024

Permalink: https://cordis.europa.eu/project/id/654662/reporting