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ONLINE EDITION

Newsletter

DEPLOYMENT OF DEEP ENHANCED GEOTHERMAL SYSTEMS FOR SUSTAINABLE ENERGY BUSINESS

Vendenheim

In the DEEPEGS project, there were two geothermal demonstration sites planned in France and the company Fonroche Geothermie had secured the exploratory licenses for the two proposed geothermal sites. However, the drilling licences managed under the French mining code, and regional approval process was required separately for both the places. This licensing process was very time consuming, and several hurdles had to overcome step by step. Repeatedly, the company needed to delay planned drillings due to the slow progress at the regional level. The timeline in the French sites slipped continually, and finally, in 2018, an alternative solution was needed within the DEEPEGS project. An alternative demonstrator site in Alsace, France that Fonroche had obtained all licences for is through a pending grant amendment being brought into the project, replacing the original two planned demonstrators in the H2020 project. The drilling work in Vendenheim started by Fonroche in 2018 and the first half of 2019 two deep wells have been drilled and becomes the DEEPEGS project's alternative French demonstration site.

The process of amending the DEEPEGS grant agreement has taken longer than was anticipated, and at this point, the partner is limiting the news on the site work in Vendenheim. The stimulation and flow testing are ongoing and more news about outcomes will be shared during the summer of 2019. The main timeline of progress is below:

- End of the drilling of Vendenheim second well 2 to 5300m on 10/02/19.
- Move again onto the Vendenheim well 1 and drill the second leg in progress of 4700 m up to 5400 m, from February to May 2019.
- The second Well tests were performed positively in May 2019.
- First well 2nd leg finalisation + tests and doublet long duration tests are forecasted to be cleared by September 2019

- SGB, JPS

The DEEPEGS project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 690771

Foreword

The H2020 DEEPEGS project is in its fourth and final year and many important discoveries have been made that will in future impact the geothermal sector. Also, unexpected interventions have been encountered that the project teams have needed to resolve and develop alternative means to progress. At the grand scale of a large demonstration project this has made our lives very challenging. Deep drilling into very hot environments provides technological challenges needing new concepts and tools to enable harnessing the vast energy in high-enthalpy volcanic geothermal fields. This includes new cementing methods, materials, drilling (Down-Hole Hammer) and casing technologies all areas of innovation in DEEPEGS. To prevent casing damage DEEPEGS is working on testing flexible couplings to take them up to a higher technological readiness level (TRL) than was previously done in the GEOWell H2020 project. Successful deployment of this innovation could in near future significantly reduce or remove risks of casing failures and this would be a great step forward for the geothermal sector.

The delayed work at the two planned test sites in France has impacted progress of work and mitigation alternative was needed and this is currently being agreed through a contract amendment with the European Commission Innovation and Networks Executive Agency (INEA) funding agency in Brussels. This Newsletter provides an update on progress at this alternative DEEPEGS geothermal site of Fonroche Géothermie in Vendenheim Alsace.

At the Reykjanes geothermal site of HS Orka in Iceland the team is getting ready for flow-testing of the well that was drilled to 4.65 km depth in early 2017. The well has been heating up for more than a year now following the work on extensive stimulation efforts. News on the flow test results and the fluid characteristics will be forthcoming later this autumn.

In the EGW 2019 conference in Haag 11-14 June project participants will be presenting papers providing insights to the project. The DEEPEGS team has submitted over 40 papers to the World Geothermal Congress (WGC-2020) scheduled for Reykjavík, Iceland in April 2020. The full results of the DEEPEGS project may not all have become available by the defined end date of the project in November 2019, but the work on demonstrating progress in economically harnessing geothermal energy will be continued. Open dissemination and communication have, in particular, been extremely effective for the Reykjanes deep well in DEEPEGS project.

- SGB

Preparation for the IDDP-2 Flow Testing continues

The Reykjanes DEEPEGS Demonstration Well – IDDP-2 – will be addressed at the EGC-2019 meeting in several talks (Friðleifsson et al., 2019; Bogason et al., 2019; Peter-Borie et al., 2019). In 2015 a pre-design of the IDDP-2 flow testing equipment had already been done by an IDDP working group, years before the drilling of the well, and described at WGC-2015 in Melbourne Australia (Einarsson et al., 2015). That design needed to be re-addressed and was finalised late autumn 2018, after the drilling of the IDDP-2 well in 2016 and 2017, and extended stimulation tests and unexpected casing damages which needed attention. After a long procurement time purchasing orders were finally made. The equipment construction on the surface is about to begin late May and could extend into July 2019. Late delivery of some equipment parts, summer vacation time and other businesses, are disturbing the desired progress a bit. The details of the design and flow test progress will be described by Jóhannesson et al. (2020) and Albertsson at al. (2020).

Originally the flow test was planned to begin the late year 2017 or early in 2018. That plan was interrupted and delayed by more than a year due to casing damage at 2.3-2.4 km depth detected by downhole logging after removing the 3½" stimulation pipe from the well in July 2017. The team discovered a small leak and potential mitigation actions needed to be scrutinized and make a decision. Finally, a decision was reached to leave it be and to flow test the well under current condition. Heating up of the well began in September 2018 and a rescheduled flow test expected to start in April 2019. For various reasons, the beginning of the test needed to be delayed further into mid or late summer 2019. The outflow from the well will be a mixture of fluids from several feed zones at different depths, whereas the majority of the flow expects to be from the 3.4 km feed zone. Depending on flow rate, some outflow from the well into the leaky casing zone at 2.3-2.4 km may occur and possibly block it up by precipitates? Speculations on differential flow from different feed points continue while the lowermost and hottest feed zones could contribute to the total outflow from ~ 2% to ~40%, while most of the flow is expected to be from the main feed zone close to 3.4 km.

- GÓF

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Seismic Monitoring at Vendenheim

In the urban area of Vendenheim, located in the suburb of Strasbourg (France), seismic monitoring is aimed, first, at mitigating induced seismic hazard and, second, at assessing the efficiency of the well doublet stimulation.
Six months before any drilling on site, FG deployed five permanent seismological stations. Among these stations, three of them consist of an antenna of four three-component geophones deployed in shallow wells down to 100 m, which is a rather unusual deployment set-up in geothermal monitoring. Additionally, one station combines a short-period, a long-period seismometer and an accelerometer. For the stimulation of the VDH-GT2 well, a temporary network of four short-period three-component stations was deployed by KIT to increase the coverage of the permanent network laterally and azimuthally.
The location of a future co-generation power plant is on an old refinery site currently converted to an "eco-park". It will provide heat to the new business premises of the zone. This environment is challenging for seismic monitoring because the anthropogenic sources of noise are numerous in this highly populated (~ 800,000 hab.) and active area: highways, main roads, construction work, railways, water canals, shopping areas, cities.

- EG

CSEM survey at Vendenheim

In the deep sedimentary basin, as found in Vendenheim, the main challenge for CSEM measurements is the high level of anthropogenic electromagnetic noise limiting the depth of penetration of classical CSEM measurements to 2 – 3 km depth, i.e. well above the depth of the stimulated zones. The objective of the survey, which will be carried out at Vendenheim following the major VDH-GT2 stimulation, is to test the possibility to increase the depth of penetration to 4 – 5 km depth by increasing the length of the electric dipole, here by a factor four and, if successful, to provide resistivity images of the deep geothermal reservoir.

- EG

Microseismicity recorded during VDH-GT2 hydraulic tests

Fonroche Geothermie began its hydraulic tests on the VDH-GT2 well on April 29, 2019, until May 16, 2019. The occurrence of microseismic events was synchronized with phases precisely identified. No event felt on the surface. The microseismicity stopped with the end of hydraulic tests and help to identify the efficiency of reservoir development with full respect and compliance with regulation and neighbourhood.

- EG

SAVE THE DATE

To go deeper in the Enhanced Geothermal Systems, we will be glad to see you at the **DEEPEGS Final workshop** (4-5 November 2019) and at the **DEEPEGS Symposium** (6-7 November 2019), hosted by the BRGM in Orléans, France.

Abstract submission will open in **July 2019**.

Testing of a laboratory prototype

This document provides a summary of the first phase of the “Development of Alternative Drive Concept for Down-Hole Hammers in Deep Drilling”. The aim was the development of drive concepts for downhole hammers, which are compatible with all standard drilling muds.
The most promising concept was chosen to develop laboratory prototype tools for initial testing. Providing energy by a mud turbine to the downhole hammer to drive an alternator (electromagnetic drill hammer) allows subsequently, the hammer transforming the electrical power into impact energy at the bit. Due to the indirect drive concept, the system can run on any drilling mud at HPHT circumstances.
During tests, the basic functionality proved the electromagnetic drive concept. For the tests, the drill bit’s rotation initiated via the strike shaft and an extendable Cardan shaft.
For this purpose, an electric motor provides energy. An eccentric screw pump at the test stands in combination with the settling tank utilized for the circulation of clear water as drilling mud. The electricity, as well as the drill hammer’s frequency, is regulated.

Figure 1: Mounted drill hammer with pipes for drilling fluid

The stroke motion is created by a linear drive, whereas an electric motor additionally provided the rotation.
The results show significant removal of rock at the granite block’s surface. However, the stroke of the shaft was significantly smaller than expected. Also, the drill hammer’s rotary motion is visible. Abrasion is extensive, but this is mainly due to the rotation of the drill hammer

Figure 2: Visible results as seen on the granite stone after testing

Optimization of the Electromagnetic Drill Hammer

Disassembling of the drill hammer was necessary due to the dissatisfying results of the drill hammer first tests and if any any damages occur.
The significant damages occurred at the shaft and the coil packs. The reason can be the inadequate bearing of the shaft within the coil packs, wherein the most significant losses can be at the coils responsible for the strike movement positioned in the middle. This situation results in less available impact energy to destruct the granite block and limits its stroke.

Figure 3: Damages at the coil (l.) and shaft (r.)

Improvements

To resolve the issue regarding the bearing of the strike shaft, semi-monocoque elements built from high-performance plastic. Due to the rings, the strike shaft can support itself at the coil packs without the metal rubbing against the packs. The shaft’s, as well as coil’s surfaces, were mended.

Figure 4: Components made from high-performance plastic

Due to the improved bearing, better results could be achieved upon conducting new tests of the drill hammer. The stroke was significantly increased compared to the first tests.

Figure 5: Results of strike experiments

Conclusion

Design met this challenge as the striking mechanism of the drill hammer is not directly supplied and in open contact with the drilling fluid. Instead, a mud turbine utilizes the hydraulic energy to create mechanical energy, which again transformed in either electrical power. This mechanism using secondary energy, thereby ultimately provides the strike energy for the bit.
This concept enables the drill hammer’s operation with all conventional drilling fluids. It is a novelty as all previously available drill hammers were only operational when using air or clear water.
Multiple test series were conducted, which gave proof of the electromagnetic drill hammer’s fundamental functionality.
It is significant removal of rock created from a granite block. However, the in-sufficient operational capability due to the strike shaft’s flaws regarding the bearing could also be observed. For recovery and better performance, the prototype was disassembled, investigated and reassembled.

- DV

How to enhance the injectivity/productivity index of the Vendenheim wells?

Reaching the requisite 200°C in Vendenheim, it is necessary to reach 4.5 km depth. Even targeting fault zones, at such depth, the plutonic basement is too tight to achieve a sufficient flow naturally. Numerical modelling performed by the BRGM currently assesses different scenario of stimulation and wellbore architectures. Company explores several possibilities: chemical stimulation, thermal stimulation, soft hydraulic stimulation and two-legs geometry in the reservoir. Some of these methods lead to enhance the connectivity between the wellbore and the natural flow path in the reservoir; others point to improve the conductivity of physical discontinuities. Firstly, separate numerical simulations based on the same conceptual model of the Vendenheim reservoir assess the efficiency of each method (see figure): thermal stimulation is assessed by numerical simulations run with the code PFC (© Itasca, Discrete element method, Thermo-Mechanical coupling); chemical stimulation with PhreeqC; Hydroshearing by soft hydraulic stimulation with 3DEC (© Itasca, Discrete Fracture Network, Hydro-Mechanical coupling); two-legs well architecture with COMPASS (Thermo-Hydraulic coupling) . Secondly, the individual results of permeability gain will integrate into a global synthetic model run with COMPASS (Thermo-Hydraulic coupling (TH)) to hierarchize their effects and to test different scenarios.

The possible co-occurrence of the different methods investigates by coupling the dominant processes to be able to catch the main mechanisms. The main innovation is the integration of all the results in the same global synthetic model.

- MP

During the EGC 2019 in The Hague, the DEEPEGS team presents the issues and lessons covering perspectives from the project management and the policy environment. Attending the conference aims to share the experience gained and discuss how the barriers might be addressed to truly enable geothermal developments to be deployed more widely and ensure that the knowledge and technical developments can more successfully be facilitated and transferred from publicly funded projects like DEEPEGS. DEEPEGS team has two oral presentations, first on day one session 1C and second on day two session 3B in addition to them it will be possible to come by to the booth of H2020 projects were DEEPEGS will have its representatives to discuss more.

Seismic activity monitoring

Since 2013, ÍSOR operated a permanent seismic network of 10 stations in Reykjanes. However, for the DEEPEGS project needs to monitor seismic activity during drilling and stimulation of the deep geothermal well RN-15 / IDDP-2, ÍSOR and KIT installed a temporary seismic network of 9 additional stations in Reykjanes from October 2016 to September 201.

The seismic catalogue contains over 2300 earthquakes, which have been manually picked and relatively relocated. The consistency of the pickings improved by cross-correlation, and focal mechanisms are computed to help characterize the local stress field. The spatial and temporal development of the seismicity is used to investigate fractures created and re-activated during the drilling and stimulation. Hence, we aim at gaining knowledge and understanding of the architecture of the deep part of the reservoir at Reykjanes. Interestingly, a zone from roughly 3.5 to 6 km depth below the geothermal producing field at Reykjanes, which was aseismic before the deep drilling, became seismically active during drilling and stimulation of the well. Increasing circulation losses below 3.0 km depth in the IDDP-2 well and a total loss of circulation from around 3.2 km depth indicate the high permeability at this depth. All the induced seismicity occurs just below the total loss of circulation and seems to group into two different fault zones with different dynamics of fault.

A likely explanation for the induced seismicity is that the total loss of circulation of cold water (below 3.2 km depth) into the previously aseismic body during drilling, completion and stimulation of the IDDP-2 well has increased the strain rate sufficiently to make this volume seismically active. As a consequence, the temperature of the previously aseismic body is almost at the brittle-ductile boundary for standard strain rates. This method opens possibilities to put better constraints on the temperature of the brittle-ductile boundary of basaltic crust in general.

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