RESULT NEWSLETTER

November 2021

Introduction

The RESULT project has now been ongoing for over a year and in this time significant progress has been made towards the project objectives. This Newsletter will provide an outline to the work carried out to date.

Project Objectives

For clean cities (mission horizon Europe) geothermal reservoirs are prospected to be developed in many urban areas with the intent of replacing fossil fuel fired heating. In many urban areas the development of geothermal reservoirs can be challenging due to suboptimal (marginal) reservoir conditions. The main objective of RESULT is to demonstrate the potential for increased performance by 30-100% of such (marginal) reservoirs for heating in urban areas, with a focus towards the northern EU.

RESULT, which stands for **Enhancing REServoirs in Urban deveLopmenT: smart wells and reservoir development,** achieves this by deploying:

1) Advanced reservoirs models and uncertainty assessments,
2) Best in class well technology options, including innovative multilateral wells,
3) Optimization methods, incorporating drill and learn strategies,
4) Optimization case studies in clastic, carbonate and volcanic settings in Europe,
5) The innovative procedure and techniques will be used and demonstrated in a field development and drilling of a geothermal doublet.

RESULT runs from September 2020 - September 2023.

WP1 Update:

Management, Communication & Dissemination

WP1 has been progressed on schedule. The the project website is now live (https://www.result-geothermica.eu/) and outputs include the Newsletters and public deliverables from the project can be found here to download.

In October 2021 the consortium members had our first in person meeting alongside the World Geothermal Congress in Reykjavik, Iceland. Representatives from ISOR, OR TNO and GDG held a project workshop and excursion to OR's Geothermal Power Plant on the 28th of October.

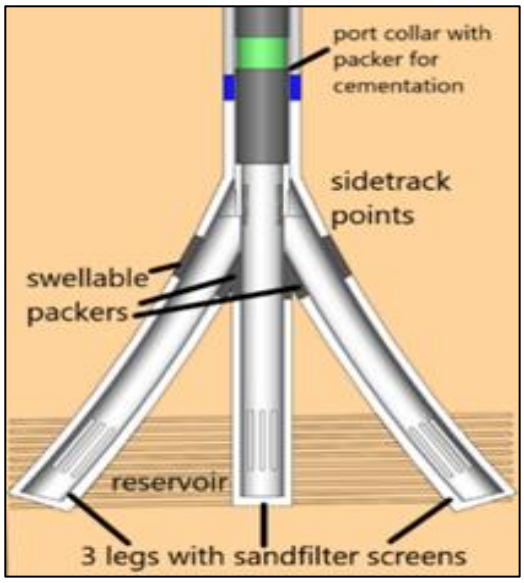
WP2 Update: Well Scenarios

Work package 2 has been completed with the delivery of the fourth and latest report in a series complementing works on well scenarios for the exploitation of marginal geothermal reservoirs.

Firstly, a literature study was conducted, providing an overview of the various completion techniques and their impact on the Injectivity Improvement Factor (IIF) and Productivity Improvement Factor (PIF). Secondly, the most promising completion techniques were further analyzed and compared in terms of their techno-economic feasibility, providing a template for studying capital expenditure, operational expenses and yield on the basis of technical parameters and financial data.

Subsequently, the insights from the rather static techno-economic template were transferred to a more capable model, providing means to evaluate a myriad of options under varying reservoir characteristics and uncertainties. The numerical model serves to support in optimization challenges

Finally, the procedure for well concept selection was exemplified, extending the numerical optimization routines for drilling and completion design to Work Package 4.



WP3 Update: Optimization Models

An optimization workflow has been developed for the initial design as well as for the progressive near real-time design improvements while drilling. The optimization workflow can be utilized in the exploration phase as well as in the reservoir development phase after first wells have been drilled. The optimization approach adapts existing optimization tools developed for the hydrocarbon industry to the geothermal sector, and takes into account:

- Capabilities to include representative 3D Reservoir structural, stratigraphic (facies) complexity, focused towards representative parametrization for reservoir flow simulation (i.e. permeability).
- Support ensembles of 3D model realizations, capturing relevant uncertainties for flow simulation and which serve as input for optimization.
- Incorporation of advanced well design features and constraints.
- KPI prediction, objective function, and multi-criteria optimization deploying the O&G optimization approach EVEReST.
- drill and learn effects (adaptive designs based on (partial) revelation of 3D model realization).

Showcasing of the models and optimization of benchmark cases for clastic, carbonate and volcanic reservoir settings is underway.

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WP4 Update:

Demonstration in a Clastic Reservoir

WP4 aims to demonstrate enhanced techno-economic performance with multi-lateral well designs and the drill & learn strategy for unlocking marginal reservoirs for district heating in white spot areas in the Netherlands. Sub-objectives are:

- Demonstrate the business case of proposed multi-lateral well design and drill and learn for marginal reservoir conditions in urban area Zwolle (the Netherlands). This includes:
- Successful construction of low cost multi-lateral wells for geothermal energy production in clastic reservoirs.
- Practical demonstration of the drill and learn approach on site, based on staged appraisal (logging, coring and flow test analysis) of yet drilled legs and fast-track adaptations for the drilling design based on optimization for the remaining legs.
- Demonstration of the production doublet based on the low cost multi-lateral design.
- Provide recommendations for development in clastic reservoirs in the Netherlands.

WP4 has started on schedule and Task 4.1 (research of the Clastic Reservoir location Zwolle) is in progress and planned to finish before the end of the year.

After this Task 4.2 can start which aims to optimize the a priori multi lateral well design for the selected site.

Task 4.3 is the actual demonstration in Zwolle and will be most likely delayed due to external preparations which are required to deliver the heat after the demonstration.

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Project Timeline:
September 2020 – September 2023

WP5 Update:

Design for Carbonate Reservoirs

The objective of this work package is to evaluate the impact of multi-lateral well designs and the drill and lean approach for deep carbonate green field reservoirs marked with limited data available:

The focus of WP5 is on deep Paleozoic carbonate lithologies in Northern Europe at two urban sites, in Ireland (Dublin area) and in the Netherlands (Nijmegen area), both of similar geological age and marked by similar basin evolution history.

Currently WP5 is focused on completing the deliverables 5.1a and D5.1b, the reservoir characterisation reports for both study areas. These reports will form the basis of analysis in the application of optimization models from WP3 on the green field reservoir exploration.

The case studies will highlight the impact of alternative well scenarios and reservoir management methodologies on reservoir exploration and exploitation. The learnings from more mature reservoir operations in Iceland and exploration and appraisal in WP4 and WP6 will help maximize the efficiency of the exploration phase and the operational phase of potential future geothermal resources developments within both the Dublin and Nijmegen areas.

WP6: Design for Volcanic Reservoirs

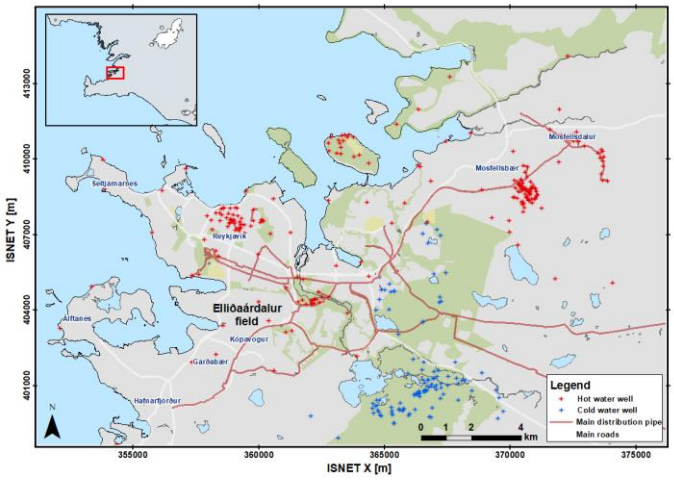
The objective from this work package is learning from past operations and studies of mature urban geothermal fields in the capital area of Reykjavik (10s of wells are used for district heating). Learnings will point out and recommend actions to stimulate geothermal hot water production from wells already drilled, with the goal of utilizing these wells to the fullest extent. Past stimulation efforts will be studied and the resulting increase estimated. This will serve as a reference case for future stimulations, both in Reykjavik and in other urban geothermal fields. A major focus will be placed on enhancing individual well performance and the lifetime of the geothermal fields to ensure sustainable utilization. A desk study on the utilized geothermal systems in the Reykjavík urban area will be performed with a principal focus on the Elliðaárdalur system. This will include reservoir analysis, drilling analysis and historical field management analysis. The study will for example include an analysis of whether the following aspects can be applied to enhance the performance of lower performing wells:

- Sidetrack laterals - Learning from the experience of RESULT partners.
- Laterals 10 meters long smaller diameters – fishbone technology.
- Radial jetting with up to 100 m laterals.
- Effect and possibility of reinjection.
- Casing depth and its effect on system behavior and utilization.
- The potential of chemical injection into production wells to prevent downhole scaling and corrosion.

To date WP 6 is on schedule with two reports completed

- Borehole Televiewer Logging in Wells R-23 and R-39 in Elliðaárdalur, Reykjavík.
- Review of stimulation efforts and guidelines for drilling and completion of low temperature wells in Elliðaárdalur field.

WP6 is currently focused on the 3D modelling of lithology and temperature in the Elliðaárdalur low temperature geothermal area, Reykjavík, SW-Iceland.



Map of the capital area in Iceland showing the location of hot and cold water wells, the main distribution pipes and the location of the Elliðaárdalur field (Data source: National Land Survey of Iceland and Reykjavík Energy).

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CONTACT:
For questions and/or comments, please contact the coordinator:

Jan Hopman
jan.hopman@tno.nl

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