Proceedings World Geothermal Congress 2026
Calgary, Canada, June 8 – 11, 2026

Heat Transfer at RINGEN Site, Czechia - Key Findings for Successful Geothermal Development

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Keywords: Distributed Temperature Sensing, thermal conductivity, hydraulic tests, borehole thermal energy storage, enhanced geothermal system

1 INTRODUCTION

The area of Litoměřice, NW Bohemia, Czech Republic, has been the subject of geothermic research since the 2000s, when the municipality became interested in geothermal energy. A pilot well, PVGT-LT1, was drilled in 2006-2007 down to 2,111 m, cutting through ~700 m of clastic sedimentary deposits of the Cretaceous and Carboniferous basins and ~200 m of a rhyolite ignimbrite down into the metamorphic basement consisting primarily of mica schist. Being the deepest borehole in the wider region, it provided invaluable information on the deep geological and thermal structure (Figure 1).

However, with an equilibrated temperature of 53°C at 1670 m depth, it became clear that at economically drillable depth, there would not be sufficient temperatures for geothermal power production, which discouraged further investment. During the following decade, research became focused on low-temperature resources and the possibility to develop an enhanced geothermal system (EGS) in metamorphic rocks for heating purposes, which led to the foundation of Research INfrastructure for Geothermal ENergy (RINGEN) in 2015. The results of this research have been summarised by Šafanda et al. (2020, 2023) and Fischer et al. (2023).

Recently, the RINGEN site has been hosting several geothermal projects, including PUSH-IT and SYNERGYS. PUSH-IT is an international project piloting various technologies of underground thermal energy storage at several sites across Europe, including Litoměřice. In 2025, shallow (200 and 500 m-deep) exploration wells LT-H2-01, LT-M2-01 and LT-M5-01, were drilled to assess the borehole thermal energy storage (BTES) potential of the sedimentary sequence. The goal of the SYNERGYS project is to then integrate three BTES systems with an EGS, solar panels and an electrolyser for green hydrogen, ultimately providing heat to the municipality's existing district heating system and making the RINGEN Centre fully energy-independent. Thorough thermo-hydraulic modelling of each system is currently underway to provide accurate estimates of the energy output and optimize the performance of the SYNERGYS system as a whole.

With surface heat flux of 76--78 mW m^{-2} (Šafanda et al., 2020, 2023), which is representative of continental crust, there is no conventional geothermal resource. However, successful geothermal development at such a common setting has a potential to shift the paradigm of possibility for the geothermal industry.

2 GEOLOGICAL, HYDROGEOLOGICAL AND GEOTHERMIC CONTEXT

The uppermost 30 m are formed of Quaternary sediments of the Elbe River terraces, composed mainly of sand and clay, followed by Cretaceous shallow-sea sandstones and marlstones belonging to the Jizera Formation (32–59 m), Bílá hora Formation (59–134 m) and Peruc-Korycany Formation (134–184 m). The Cretaceous sequence hosts two major aquifers. The upper aquifer is hosted in fractured Turonian sandstones. The lower aquifer has a thickness of approximately 40 m (140 – 180 m) and is hosted in poorly consolidated and highly porous sandstones of Cenomanian age. Beneath the Cretaceous formations, the Upper-Carboniferous to Lower-Permian continental siliciclastic sediments were found, consisting successively of the Líně Formation (184–426 m), Slaný Formation (426–493 m), and Týnec Formation (493–516 m), with alternating sandstones and siltstones/mudstones locally enriched with organic matter.

A 200 m-thick rhyolite ignimbrite at the base of the basin lies on top of the metamorphic basement formed by Variscan mica schist with foliation dipping steeply to the south. The schist has a very low hydraulic conductivity in the order of 10^{-12} m s^{-1} (Fischer et al., 2023).

The temperature profile measured in 2018 (11 years after drilling) shows the temperature of 53°C at 1670 m. Geothermic models run by Šafanda et al. (2020) forecast temperature of approximately 140°C at the depth of 5 km.

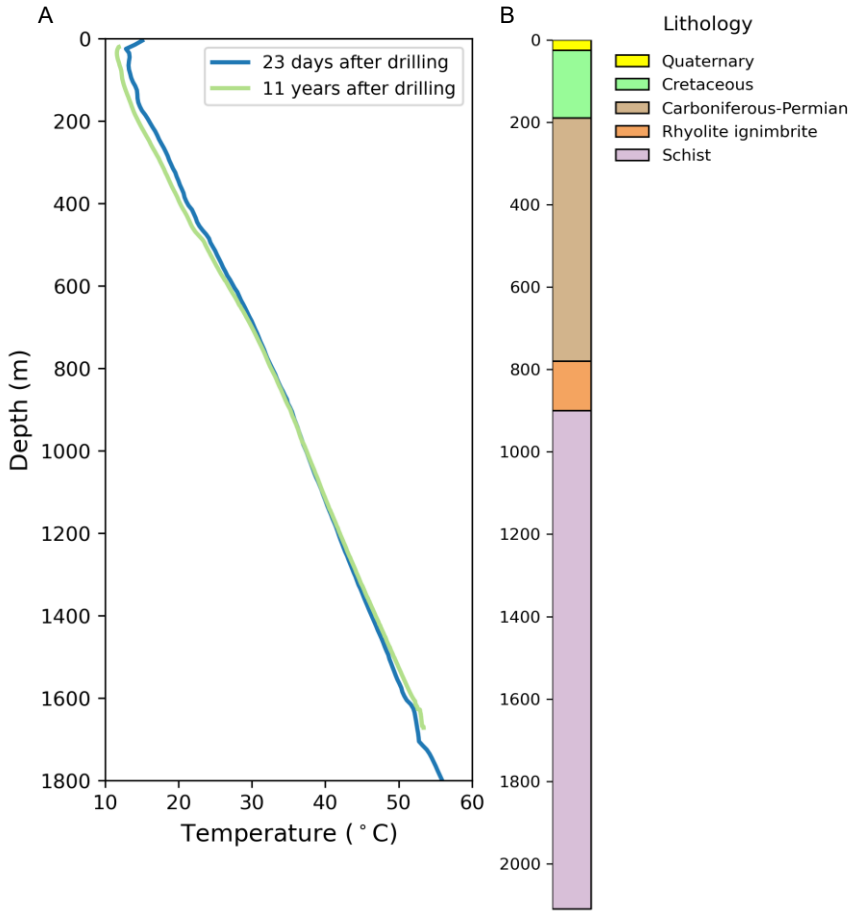


Figure 1 Temperature profile measured in PVGT-LT1 (A) shortly after drilling in 2007 and then again in 2018. The well was cased down to 850 m and had a liner to 1800 m, perforated between 1600 and 1700 m. A simplified lithological profile is added for reference (B)

3 METHODS & RESULTS

In terms of geothermal play characterisation, RINGEN site targets (1) a low-temperature and low-permeability petrothermal system of crystalline rocks with the aim of developing an enhanced geothermal system (EGS) for heating purposes, and (2) a shallow sedimentary system for underground thermal energy storage (UTES).

Hence, for accurate reservoir characterisation, it is essential to understand fracture systems within the crystalline rock (1) and thermal properties of the sedimentary sequence (2).

3.1 Hydraulic injection tests in the pilot borehole PVGT-LT1

Two hydraulic injection tests carried out in the pilot geothermal borehole PVGT-LT1 in 2020 were the first opportunity to study the reservoir behaviour of the deep system and have been thoroughly described by Fischer et al. (2023). The liner had been removed and a fibre-optic cable had been installed in the well before the start of injection and was used for temperature monitoring by Distributed Temperature Sensing (DTS) during the injection and for months after shut-in. A pre-existing fracture was reactivated in the ignimbrite during the first test in 2020 and re-opened during the following test 7 months later. A thermal anomaly observed in Figure 2 suggests the fracture remained open, as local cooling is observed for days after shut-in. The second temperature anomaly at ~850 m is most likely caused by a large cavity at the casing shoe, which was confirmed by caliper logs. Since the temperature field remained unchanged below 880 m, it is unlikely that any fracturing happened in the schist basement.

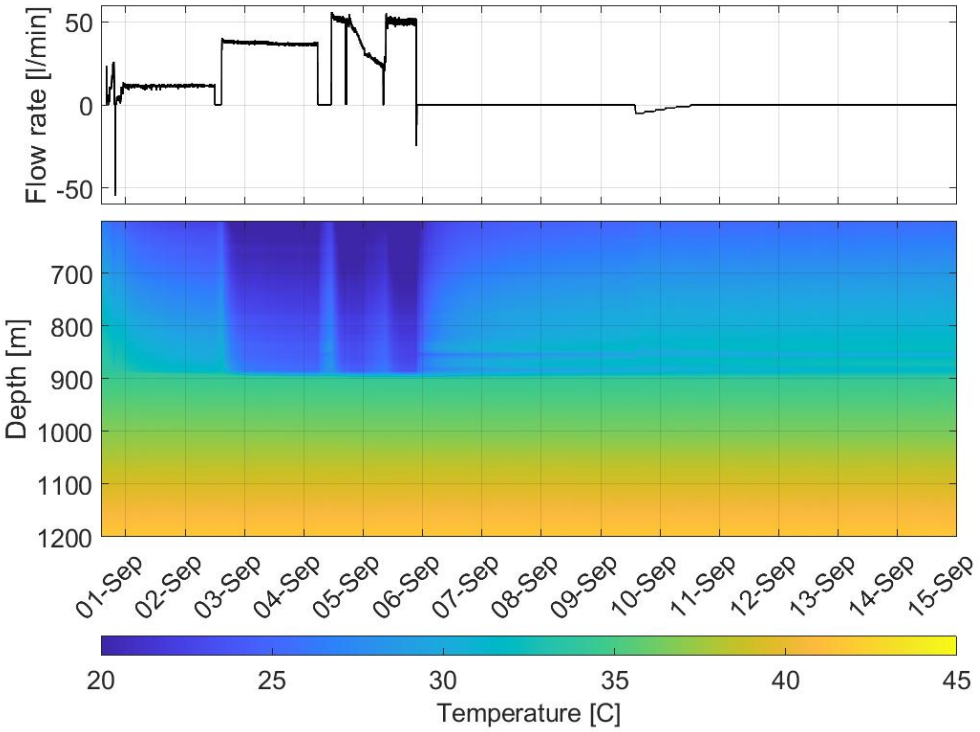


Figure 2 Temperature evolution measured in PVGT-LT1 by DTS during hydraulic testing in 2019. Two temperature anomalies remained at ~850 and ~880 m after the end of the test, suggesting an open fracture or a large cavity in the wellbore. Modified after Fischer et al. (2023)

3.2 Laboratory measurements for thermal energy storage design

To guide the design of the three distinct BTES fields, thermal properties of the Cretaceous and Permo-Carboniferous sediments were measured on cores from LT-M5-01 and LT-M2-01 boreholes and described by Krejzlová (2025). The Cretaceous Bílá Hora Formation is planned for low-temperature BTES to the depth of approximately 100 m ("BTES 1"), where thermal conductivity is relatively high (between 2.75 to 3.25 W $m^{-1} K^{-1}$, as shown in Figure 3), staying clear of the insulating layer of <2 W $m^{-1} K^{-1}$ beneath. The medium-temperature "BTES 2" is planned to be developed in the Peruc-Korycany Formation hosting the Cenomanian Aquifer and exhibiting large thermal conductivity of up to 4 $Wm^{-1}K^{-1}$. The design and technology of heat storage in BTES 2 will be specified after the velocity and direction of groundwater flow have been determined. The high-temperature BTES 3 will likely target Permo-Carboniferous sediments. The thermal conductivity of the Carboniferous sequence was measured to a depth of 516 m, where a zone with very low thermal conductivity (450–480 m) was encountered (Figure 3). This zone thus defined the maximum depth for the BTES 3 field.

Measurements were performed on drill core samples at 1 m intervals. Water-saturated samples were measured immediately after drilling, and dry samples were measured later after drying in an oven. Figure 3 shows the relationship between thermal conductivity, thermal diffusivity, and volumetric heat capacity of dry and saturated samples and their porosity. The importance of water content is evident here, as it has a heat capacity several times greater than the rock matrix and a thermal conductivity an order of magnitude higher than air.

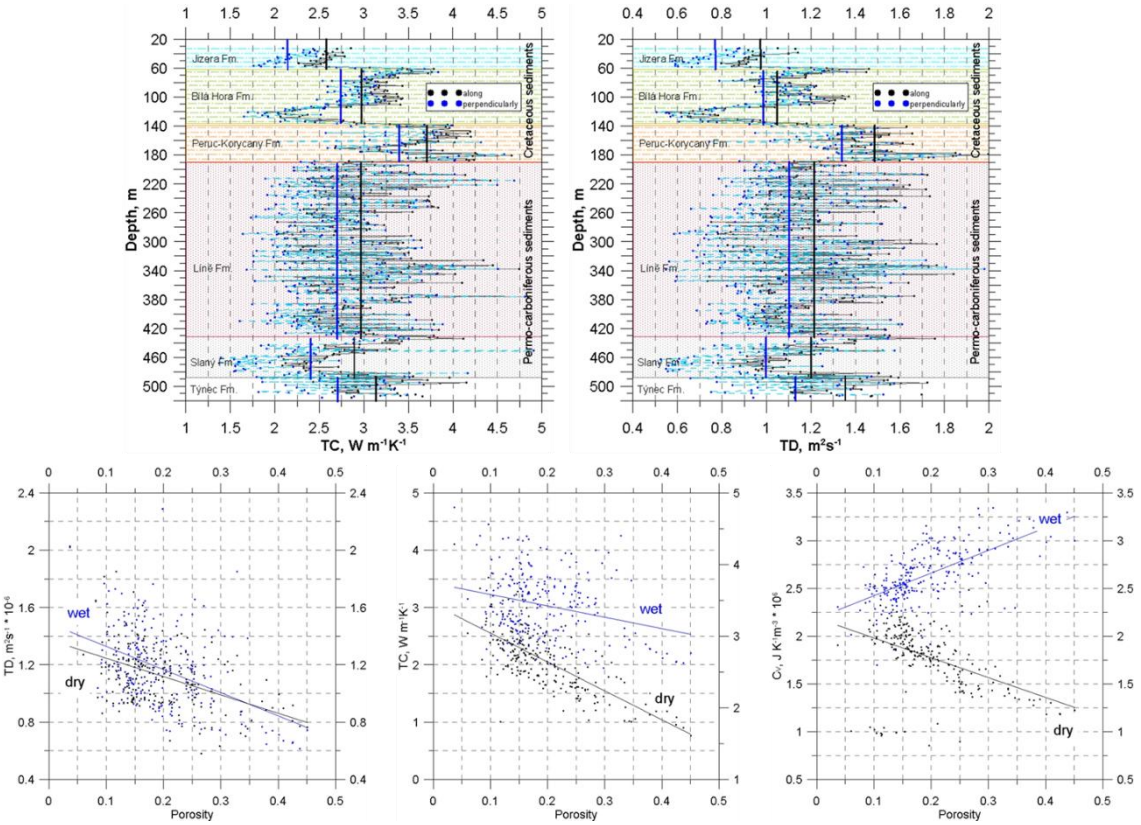


Figure 3 Upper row: Results of thermal conductivity and thermal diffusivity measurements along and perpendicular to the bedding planes in the case of water-saturated samples. Solid lines represent average values in individual lithological units. Lower row: Relationship between the thermal conductivity, thermal diffusivity and volumetric heat capacity of dry and saturated samples and their porosity.

4 DISCUSSION & CONCLUSIONS

Dynamic models of thermal energy storage are continuously being updated with new data on thermal conductivity and groundwater flow in the sedimentary sequence, thus guiding the design of BTES fields including the depth and spacing of boreholes. At the time of submission of this paper, drilling of the shallow BTES 1 field was yet to commence.

Simultaneously, work is ongoing on the design of the EGS well aimed at targeting the metamorphic basement at 3 km-depth, later supplemented by data on fracturing and stress measured in early 2026. In these impermeable and highly anisotropic rocks, heat transfer is purely conductive, advection may only occur in permeable fractures. Should the local stress field be aligned with the regional stress field in NNW-SSE direction, most current natural fractures are unlikely to re-activate (Šafanda et al., 2020), so the reservoir needs to be artificially developed by stimulation. When additional borehole televiewer data are acquired, a discrete fracture network model is to be built to aid the stimulation design.

A seismic network is in place, continuously monitoring natural seismicity and confirming current very low seismic background. For the EGS reservoir development, the network is planned to be densified to increase sensitivity for detecting and accurately locating newly opened fractures. Detailed traffic light system is to be introduced in order to mitigate induced and triggered seismicity.

Drilling wells for all the systems is planned for 2026-2027 and system integration should take place in 2028. Once in operation, SYNERGYS is expected to supply at least 1 MW the town's district heating system from the BTES fields. and almost 2 MW from EGS, although its primary purpose is to serve as a working example for upscaling geothermal developments beyond the current state-of-the-art.

Acknowledgements

The SYNERGYS Project – Systems for Energy Synergy was supported by the Operational Programme Just Transition 2021–2027 under registration number CZ.10.02.01/00/22_002/0000172, within Call 10_22_002 of the Ministry of the Environment. Exploration boreholes LT-M5-01 and LT-H2-01 were drilled within the PUSH-IT project funded by Horizon Europe programme (grant no. 1011096566). Views and opinions expressed are

however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor CINEA can be held responsible for them.

REFERENCES

Fischer, T., Vlček, J., Dědeček, P., Řihošek, J., Zimmermann, G., Holeček, J., Mazanec, M., Rukavičková, L., Janků, L., & Káldy, E. (2023). Hydraulic injection tests in the pilot EGS borehole PVGT-LT1 in Litoměřice, Czechia. *Geothermics*, *115*, 102805. https://doi.org/10.1016/j.geothermics.2023.102805

Krejzlová, K. (2025). *Effect of porosity and water content on thermal properties of sedimentary rocks* [Bachelor's Thesis]. Charles University in Prague.

Šafanda, J., Dědeček, P., Čermák, V., & Uxa, T. (2023). Heat flow variations in 2 km deep borehole Litoměřice, Czechia. *Geothermics*, *111*, 102708. https://doi.org/10.1016/J.GEOTHERMICS.2023.102708

Šafanda, J., Verner, K., Franěk, J., Peřestý, V., Holeček, J., & Fischer, T. (2020). Geology and geothermal potential in the eastern flank of Eger Rift (Litoměřice area, Czech Republic). *Geothermics*, *86*, 101808. https://doi.org/10.1016/J.GEOTHERMICS.2020.101808