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Feasibility study on the repurposing of the well doublet at the Groß Schönebeck research platform

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ABSTRACT

The Groß Schönebeck site offers a unique opportunity to promote geothermal innovation in Germany via three distinct development pathways. One approach is an Enhanced Geothermal System (EGS), which involves repurposing an existing well (Gt GrSk 4/05 (A2)) for injection. However, challenges regarding fracture sustainability, scaling and long-term performance require further investigation before the economic viability can be assessed. A nearer-term alternative is a coaxial Deep Borehole Heat Exchanger (DBHE) system that leverages exceptional subsurface temperatures and existing well infrastructure. Simulations suggest a potential thermal power output of 500–750 kW over 30 years, provided insulation performance and well integrity are validated. A third pathway focuses on medium-depth hydrothermal resources within surrounding formations. This involves characterizing the reservoir, developing a tailored doublet and optimizing materials for hypersaline conditions. Critically, existing deep wells can be repurposed for comprehensive monitoring supporting the third pathway. The site's advantages: pre-existing and high-temperature deep wells; proximity to district heating networks; and a controlled research environment, can further facilitate adaptive investment. From near-term DBHE deployment to future EGS expansion, Groß Schönebeck offers a scalable solution for advancing geothermal energy in Germany. Further research focused on long-term performance and material optimization is essential to unlocking the site’s full potential.

1. INTRODUCTION

Situated approximately 40 km north of Berlin in the North German Basin, Groß Schönebeck site represents a valuable research platform for the development of geothermal technologies. The development of this site has been accompanied by over two decades of research. The site's first deep well, designated E GrSk 3/90, was originally drilled in 1990 for gas exploration targeting the Rotliegend reservoir. Notwithstanding the insufficiency of hydrocarbons, the well exhibited a bottom-hole temperature of 149°C at 4240 m TVD, thereby establishing Groß Schönebeck as a potentially promising deep geothermal test site within North-Eastern Germany. In a subsequent development, a geothermal well, designated Gt GrSk 4/05 (A2), was drilled a well doublet. Since that time, these two deep wells have formed the core of a research platform for advancing geothermal energy technologies. The present study assesses two potential approaches to harnessing geothermal energy at the site, involving the repurposing of the existing well doublet as part of the TRANSGEO project (**Figure 1**). The study was developed using reservoir models for the two main technological approaches: Enhanced Geothermal Systems (EGS) and Deep Borehole Heat Exchange (DBHE) systems. The third option involves the utilization of the existing deep wells for the purpose of

monitoring, supporting the medium-depth hydrothermal resource development that has been proposed in Groß Schönebeck.

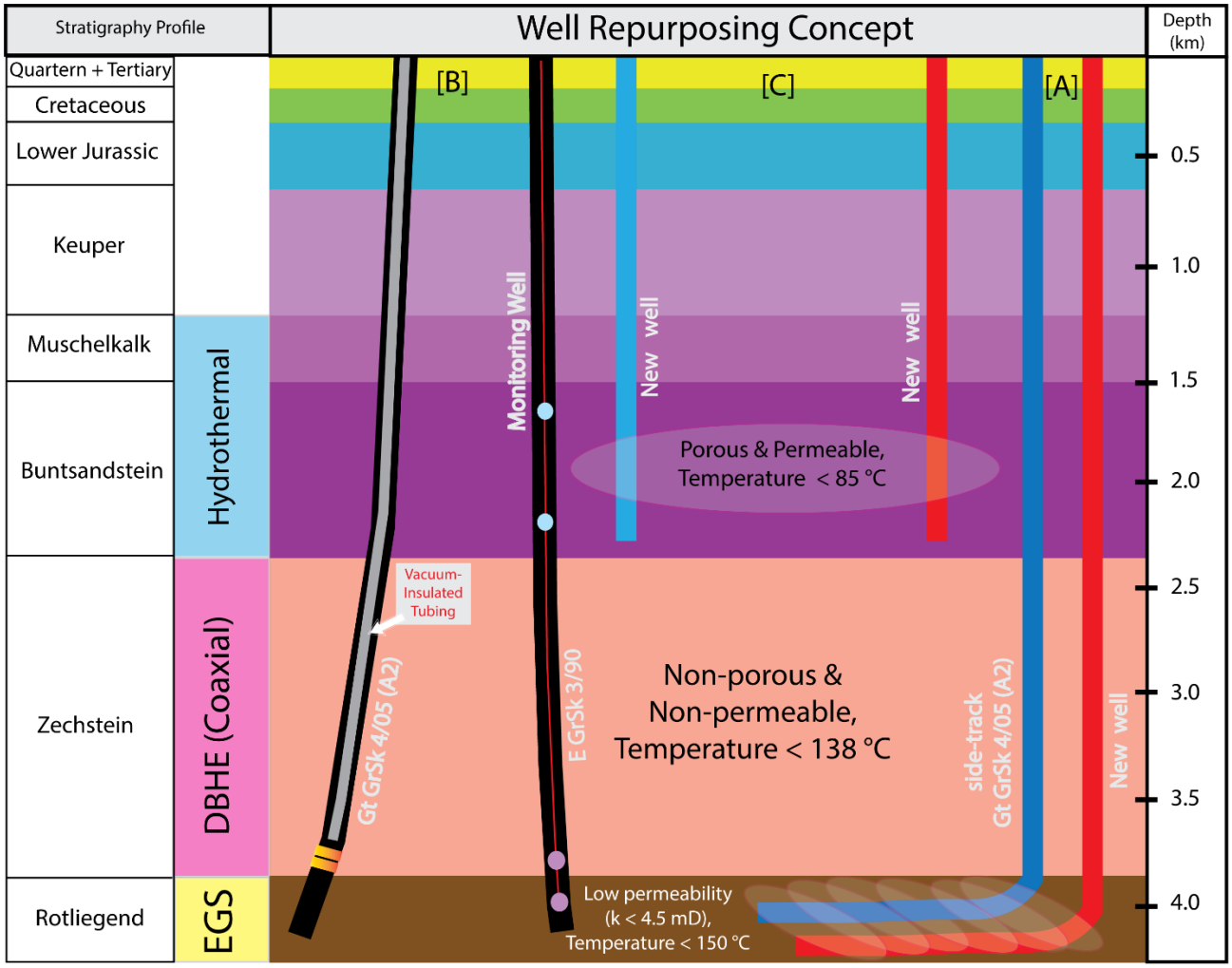

Fig. 1: The well repurposing concept at the Groß Schönebeck site. [A]: Repurposing the Gt GrSk 4/05 (A2) well as an EGS injection well. [B]: Repurposing an existing well to serve as a DBHE system; [C]: Repurposing an existing well for use as a monitoring well for medium-depth hydrothermal resource development.

2. ENHANCED GEOTHERMAL SYSTEMS (EGS)

The EGS pathway aims to access thermal energy within the Rotliegend sandstone formation (at a depth of over 4 km) by repurposing the Gt GrSk 4/05 (A2) well as an injection well to minimize surface disturbance. A sidetrack from the 13.375” casing (at ~2116 - 2200 m MD) has been proposed for use as an EGS injection well (**Figure 1[A]**). Recent tests confirm its suitability, but further integrity verification and the use of non-carbon steel materials are required. The reservoir model, which has been validated against hydraulic tests (2011–2013), indicates that matrix permeability is the most influential parameter governing performance. A 16-stage fracture-dominated development concept is proposed, which is projected to yield a 16-fold increase in productivity and injectivity indices compared to previous matrix-dominated EGS concepts, achieving a production rate of 60 - 180 m³/h over 30 years with scenario of one or two new production wells. However, uncertainties remain regarding the

long-term sustainability of fractures, the efficiency of multi-fracture stimulation and well completion with regard to scaling-induced clogging. This hinders a reliable economic assessment and necessitates further research. The former hydrocarbon well E GrSk 3/90 can be repurposed as a seismic monitoring well for the purpose of EGS development.

3. DEEP BOREHOLE HEAT EXCHANGERS (DBHE)

The DBHE concept offers a near-term, low-risk strategy that utilizes the existing well doublet and the thermally conductive Zechstein formation. The present study investigates the performance of a coaxial DBHE when set up at an optimum completion depth of 3,800 m MD with a maximum casing diameter of 7 inches (**Figure 1[B]**). The result demonstrated that, at this depth, with a maximum temperature of 138°C, inlet temperatures ranging from 10 to 25°C, and a flow rate of up to ~26 m^3/h, it is possible to achieve outlet temperatures ranging from 49 to 67°C over a period of 30 years. This process results in the generation of 500 - 750 kW of thermal power. The simulation, which was conducted in order to explore the relationship between tubing dimensions and materials, has confirmed that direct heating is the most suitable application, with a Levelized Cost of Heat (LCOH) of 7-14 ct €/kWh. An efficient system requires at least 2.88"/2.44" (OD/ID) vacuum-insulated tubing with low thermal conductivity (≤ 0.06 W/m K). The field validation of heat transfer parameters must necessarily be prioritized.

4. UTILIZING EXISTING WELLS FOR EXPLORATION AND MONITORING TO SUPPORT MEDIUM-DEPTH HYDROTHERMAL RESOURCE DEVELOPMENT

This pathway involves investigating access to medium-depth hydrothermal resources within the Muschelkalk and Buntsandstein formations surrounding the local salt structure. It involves repurposing existing deep wells as analogue wells for exploration and one of them as a monitoring well (seismic, pressure and fiber optics) during the development and operational phases (**Figure 1[C]**).

5. CONCLUSION

This multi-pathway assessment demonstrates the significant potential of diverse geothermal resources and technologies at Groß Schönebeck. While EGS requires continued technological advancement and supportive policies to overcome high initial costs, the DBHE concept offers an immediately feasible pathway for cost-effective heat supply from existing wells intersecting low permeability, high thermal conductivity and high temperature rock, particularly near established district heating networks. Medium-depth hydrothermal resources present a promising avenue for expanding regional geothermal contributions, by utilizing existing wells for exploration and monitoring purposes. Realizing these opportunities hinges on continued research, demonstration projects, innovative business models, and collaborative efforts involving industry, academia, and government agencies. Integrating geothermal resources with other renewable sources (solar, wind) will create a resilient, cost-effective energy system, contributing to Germany’s climate objectives and securing a sustainable energy future.

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