Where do we drill? Dimensional accuracy of conventional and innovative hydraulic GeoJetting drilling technology

Jörg Riechers, Rolf Bracke
GZB – International Geothermal Center

Summary

For enhancing the contribution of geothermal energy a continuous research and development is required. Especially the drilling technology has a significant potential. The economic efficiency of geothermal project depends on accruing drilling costs. The borehole quality and environmental compatibility during the drillings are largely depending on the selected drilling method. Environmental impacts during the drillings are affected by the fuel consumption of the power equipment for the drilling system and the drill rig. The purity of the used working and flushing fluid, depending on the selected drilling method, are impacting the environment.

In context of a research project of the 'GZB' in Stockholm, Sweden, the aim was to investigate whether the innovative hydraulic GeoJetting drilling technology in an alternative to a pneumatic DTH-System in the field of geothermal drilling.

Introduction

An efficient working drilling technology influences the economic efficiency of geothermal drilling. Furthermore there is a growing interest in the environmental compatibility of the drilling method and the quality of the bore hole, in particular the straightness. On the one hand environmental impacts during the drillings are affected by the fuel consumption of the power equipment for the drilling system and the drill rig. On the other hand the purity of the used working and flushing fluid, depending on the selected drilling method, are impacting the environment.

The drilling method directly influences the dimensional accuracy of a borehole. Strong deviations from the vertical direction may result in a mutual influence of geothermal wells. Therefore the simulated heat extraction values could not be realized. In addition there is a problem of mutual damage of the heat exchangers during the drillings.

The goal of the 'GZB' in the spring of 2010 in Stockholm, Sweden, conducted research project was to compare the dimensional accuracy of conventional and innovative hydraulic GeoJetting drilling technology directly to a reference project and to analyze the environmental impact of both drilling methods.

Reference Project

In Stockholm, 29 geothermal wells for supply of two adjacent terrace houses, with a planned depth of 220 m and 250 m plus and declination between 0° and 8°,because of limited space, were drilled. For clarity and avoidance of mutual influence all wells were separated according to the used drilling method into drilling fields. In field I 14 wells were drilled with a pneumatic DTH-Drilling-System. The innovative hydraulic system has been used in Field II for 15 wells.

According to the Swedish Geological Survey the bedrock in the drilling area has an irregular alternation of granite and gneiss. The gneiss shows intrusions of granite and pegmatite courses. The plastically deformed rock is very fragile and an increased water flow in the subsurface is expected.

Results

As a basis for later analysis detailed drilling and measurement protocols were conducted. Almost all boreholes were measured by a 'Flexit-Multi-Smart-System'. The measured data for each station were the declination- and azimuth angle, the northing and easting.

Borehole deviation: The deviations of the boreholes from the planned direction are up to a depth of 40 m 50 % higher in field 1 (pneumatic system) than in field II. Generally high requirements for the drilling method are set by the bedrock. Nevertheless the maximum deviation of the boreholes, which were drilled with the hydraulic DTH-System, is only about 48 m. This is a 65 % lower deviation as in field I (Fig. 1).

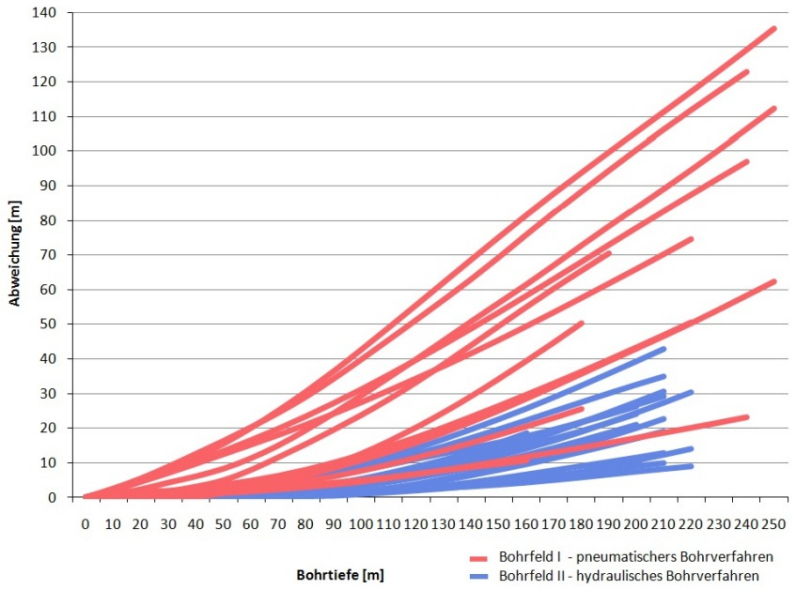

Fig 1: *Diagram illustrating the deviations of the drilled boreholes. The blue lines represent the innovative hydraulic DTH-System (field I) and the red lines stand for a standard pneumatic system (field II).*

Water & fuel consumption: The drive unit of the used high-pressure pump (working pressure ≈ 180 bar) has a capacity of 183 kW. In contrast, the used air-compressor (working pressure ≈ 32 bar) in field I has a capacity of 430 kW. A 57.4 % lower driving power lead to a significantly lower fuel consumption. Therefore the average fuel consumption by using the pneumatic DTH-System is 75.9 % higher and causes much higher operating costs. The water consumption of the hydraulic system is 0.6 m^3/m.

Conclusion

The predominant advantages of the hydraulic DTH-System show that this variant is definitely an alternative to existing drilling methods for hard rock drillings.

Due to lower fuel consumption and increasing fuel prices the hydraulic hammer offers cost benefits. This leads to decreasing drilling costs which in turn increases the economic efficiency of geothermal project. Only small borehole deviations enable drillings in narrow building structures and encourage new geothermal application fields, because of the possibility of low borehole spacing.

It turns out that research and development in the area of drilling technologies has great potential. The development of the hydraulic DTH-System is a step towards the right direction.