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Thermal Drilling Technologies based on a Lasersystem for hard rock and geothermal reservoirs

S. Jamali, V. Wittig, Dennis Schwarz, R. Bracke,
International Geothermal Centre Bochum

Abstract

The deep drilling industry last introduced fundamental technical improvements at the turn of the twentieth century by replacing cable tool drilling with rotary drilling process. Since then, rotary drilling has seen numerous incremental enhancements. However, it still performs poorly especially in hard formations. While e.g. geothermal resources tend to be found in deeper and harder formations than O&G, for their economic recovery innovative and fundamental changes in the prevailing, conventional drilling process have long been overdue. However, no physical changes to the basic mechanical rock breaking have since been introduced to address the exponentially increasing technical challenges, leading to poor economics in today's deep, hard rock drilling. Problems include very low ROP coupled with very high tool wear.

Attempts to e.g. develop alternative means for delivering more energy to the bit and break rock differently have been under way worldwide in the past 20 to 30 years. Thermal drilling could potentially be such next fundamental change and thus, greatly improve drilling of hard rock. GZB in Bochum is investigating such innovative thermal drilling technologies, especially Laser / spallation Drilling as well as Plasma drilling. For the first, a laser beam is being sent onto rock´s surface, causing the temperature to increase instantaneously and thus, weaken the rock structure through thermal stresses. Subsequently, the now weakened rock will be further broken / drilled using mechanical means. This process runs continuously, as cuttings are being removed via drill mud / fluid as in any rotary system.

Outside of the lab, the completely assembled Laser drilling BHA and process will be tested with GZB`s drill rig at surface as well as under actual in-situ HP / HT reservoir conditions as they occur in a geothermal reservoir. This is being done in the new In-Situ Borehole and Geofluid Simulator (iBOGS) at GZB in Bochum. The iBOGS is capable of simulating drilling and production processes under reservoir conditions down to 5.000 m depth.

The preliminary lab and field tests and results of thermal Laser drilling will be discussed, showing differences and advantages over conventional drilling methods including energy to the bit, ROP, bit life time, etc.

Furthermore, a new LaserJet drill bit, required changes and modifications to be implemented in the present drill string equipment and analyses of the possible advantages and disadvantages are also being described and presented.