Laser supported thermal drilling for Geothermal and Hard Rock Applications

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The interest in geothermal energy has been growing substantially over the past years, but a more widespread exploitation of deep geothermal energy is still dependent on novel, adequate drilling technologies that may overcome the challenges in drilling into geothermal reservoirs. Main technical challenges of today hard rock drilling, resulting in poor economics, mainly include low rate of penetration (ROP), limited delivery of energy to bottom hole assembly (BHA), high bit wear and thus, low tool life. Thermal drilling processes, e.g. based on laser technologies, has been under development at GZB in Bochum, to overcome the latter problems in hard rock drilling by applying more energy in form of thermal energy into the rock. A combined laser-water-jet is used to deliver additional energy to the rock surface. The laser-water-jet operates via a laser beam being coupled into a water-jet by using the physical principle of total internal reflection. The LaserJet is protected through an air shrouding method from the drill head exit nozzle till it reaches the rock surface. The Laser beam induces thermal stress by a rapid increase in temperature, which consequently does result in, rock’s mechanical strength reduction and also its spallation. The spalls will be washed away and flushed out by traditional means of cuttings transport via the drilling mud system. the possibly remaining, now softened hard rock elements, will be crushed and removed with the optimized mechanical drill bit, assisting in the overall thermal drilling process. Parallel, GZB developed a new, multi sensoric MWD system (MOUSE) as the main control mechanism to quantify, monitor and evaluate the process during rock breaking and drilling. LaserJet Drilling (LJD) lab test results will be discussed in detail alongside technical comparison with DTH hammer and other novel drilling methods. Furthermore, the complete Laser drilling system setup including BHA, and LJD field tests will be discussed and presented.