Deep Plasma Pulse Geo Drilling (PPGD) Performance

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Geothermal energy is, in principle, a limitless energy resource that can work as a decentralized power source assuming the implementation of the enhanced or advanced geothermal systems, which requires drilling at least 5 km deep, i.e., into hard crystalline basement rocks. However, drilling to such depths is currently too expensive as it, resulting in specific capital electricity costs of about 145 [$\$W_e^{-1}$]. These costs need to be reduced down to about 2-5 [$\$W_e^{-1}$] in order to be able to compete with other renewable energy sources [1]. Therefore, developing significantly cheaper drilling technologies, e.g., Plasma Pulse Geo Drilling (PPGD), are necessary to utilize such geothermal energy resources. During PPGD, two electrodes transmit high-voltage pulses at >200 kV and rise times <0.5 μs to the rock surface, inducing electric breakdown inside the rock and thus rock fracturing [2].

Under ambient conditions, PPGD has proven to be cheaper than mechanical rotary drilling [3, 4]. Nonetheless, PPGD performance at depth (i.e., at high lithostatic and hydrostatic pressures and temperature) is unknown. We thus conduct experiments, where we apply 200 kV pulses with 30 nanoseconds rise time to granite samples, placed in one of the following setups, i.e., drilling cells. The first is a bi-axial cell that can apply lithostatic pressures of up to 150 MPa. The second is an autoclave which can be heated to 80 °C and exert a hydrostatic pressure of up to 50 MPa. We show results of these experiments which shed light on the viability of the PPGD process as a deep drilling technology and highlight the key factors driving PPGD drilling success.

References

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