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# On the effects of the lithostatic, hydrostatic pressures, and the temperature on Plasma Pulse Geo Drilling (PPGD)

*Monday, 30 May 2022 16:20 (15 minutes)*

Geothermal energy is, in principle, a limitless energy resource that exists everywhere. Geothermal energy can be used as a baseload power source (i.e., it is available at all hours of the day throughout the year) or as a dispatch power source (i.e., it can support other intermittently available energy sources, such as wind and solar, by providing power when there is no wind or sunshine). However, producing heat or generating electricity from geothermal reservoirs, employing so-called "advanced"[1] or "enhanced"[2] geothermal systems, requires deep drilling into rock layers (i.e., crystalline basement) that exhibit temperatures 150$^{o}$C[3]. For example, drilling to depths of 5 km is required in Europe to reach the required temperatures (150$^{o}$C), given that the geothermal temperature gradient is typically 30$^{o}$C/km.

Drilling costs, particularly into crystalline basement rock, can contribute up to 80% of the total investment required for a geothermal power plant when using mechanical rotary drilling, which can render such power plants uneconomical. High drilling costs can be attributed to long tripping times, which is the time spent replacing worn or damaged drill bits once the often short lifetime of a drill bit has been exceeded. Contactless drilling methods, however, do not rely on mechanical abrasion, thereby eliminating mechanical abrasion and extending the lifetime of the drill bit[4–7]. Plasma Pulse Geo Drilling (PPGD) in particular uses high voltage pulses that last for a few microseconds to fracture the rock[8–12]. During PPGD, two electrodes transmit these pulses to the rock surface, inducing plasma formation inside the rock pores, increasing the pore pressure, exceeding the rock tensile strength, and causing rock fracturing. Under ambient conditions, PPGD has proven to be cheaper than mechanical rotary drilling, and further research and development could reduce the cost by 90%, compared to rotary drilling costs[3,13]. Nonetheless, no experimental work on PPGD drilling investigates deep well pore conditions, i.e., high lithostatic pressures, hydrostatic pressures, and temperatures.

This study aims at understanding the effect of the aforementioned conditions on the following five parameters: (1)PPGD performance (i.e., excavated rock volume per electric pulse); (2)Specific excavation energy (i.e., required energy to excavate a unit volume of the rock); (3)Cutting size (i.e., rock fragment size resulting from PPGD drilling); (4)Relative penetration depth (i.e., the penetration depth per unit inter-electrode gap distance); and (5)Pre-damage phase of the PPGD process.
The experimental design uses a bi-axial cell that can apply lithostatic pressure of up to 150MPa (i.e., simulating 5 km deep conditions) on a granite specimen(Figure 1a). Deionized water immerses the entire experiment setup, i.e., simulating the drilling fluid. Next, a few dozen electric pulses of 200kV, with rise-times shorter than 0.5 microseconds, are applied to the specimen. To investigate the effect of hydrostatic pressure and of temperature, rock specimens are placed in the so-called i.BOGS autoclave(Figure-1b). Pressures up to 50 MPa and temperatures up to 80$^{o}$C can be reached in the i.BOGS. The results of these experiments shed light on the viability of the PPGD process as a deep drilling technology and highlight the key factors driving PPGD drilling success.

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## Country

Switzerland

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## Time Block Preference

Time Block A (09:00-12:00 CET)

## Participation

In person

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