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Large scale in-situ BOrehole and Geofluid Simulator (i.BOGS) for the development and testing of borehole technologies at reservoir conditions

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A fundamental problem of technological applications related to the exploration and provision of geothermal energy is the inaccessibility of subsurface processes. As a result, actual reservoir properties can only be determined using (a) indirect measurement techniques such as seismic surveys, machine feedback and geophysical borehole logging, (b) laboratory experiments capable of simulating in-situ properties, but failing to preserve temporal and spatial scales, or vice versa, and (c) numerical simulations. Moreover, technological applications related to the drilling process, the completion and cementation of a wellbore or the stimulation and exploitation of the reservoir are exposed to high pressure and temperature conditions as well as corrosive environments resulting from both, rock formation and geofluid characteristics.

To address fundamental and applied questions in the context of geothermal energy provision and subsurface exploration in general one of Europe's largest geoscientific laboratory infrastructures is introduced. The in-situ Borehole and Geofluid Simulator (i.BOGS) allows to simulate quasi scale-preserving processes at reservoir conditions up to depths of 5000 m and represents a large scale pressure vessel for iso-/hydrostatic and pore pressures up to 125 MPa and temperatures from –10°C to 180°C. The autoclave can either be filled with large rock core samples (25 cm in diameter, up to 3 m length) or with fluids and technical borehole devices (e.g. pumps, sensors). The pressure vessel is equipped with an ultrasound system for active transmission and passive recording of acoustic emissions, and can be complemented by additional sensors.

The i.BOGS forms the basic module for the Match.BOGS finally consisting of three modules, i.e. (A) the i.BOGS, (B) the Drill.BOGS, a drilling module to be attached to the i.BOGS capable of applying realistic torques and contact forces to a drilling device that enters the i.BOGS, and (C) the Fluid.BOGS, a geofluid reactor for the composition of highly corrosive geofluids serving as synthetic groundwater / pore fluid in the i.BOGS.

The i.BOGS will support scientists and engineers in developing instruments and applications such as drilling tooling and drillstrings, borehole cements and cementation procedures, geophysical tooling and sensors, or logging/measuring while drilling equipment, but will also contribute to optimized reservoir exploitation methods, for example related to stimulation techniques, pumping equipment and long-term reservoir accessibility.