



## **Single well thermal tracer test, a new experimental set up for characterizing thermal transport in fractured media**

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Thermal transport in fractured media depends on the hydrological properties of fractures and thermal characteristics of rock. Tracer tests using heat as tracer can thus be a good alternative to characterize fractured media for shallow geothermal needs. This study investigates the possibility of implementing a new thermal tracer test set up, the single well thermal tracer test, to characterize hydraulic and thermal transport properties of fractured crystalline rock.

The experimental setup is based on injecting hot water in a fracture isolated by a double straddle packer in the borehole while pumping and monitoring the temperature in a fracture crossing the same borehole at greater elevation. One difficulty comes from the fact that injection and withdrawal are achieved in the same borehole involving thermal losses along the injection tube that may disturb the heat recovery signal. To be able to well localize the heat influx, we implemented a Fiber-Optic Distributed Temperature Sensing (FO-DTS) which allows the temperature monitoring with high spatial and temporal resolution (29 centimeters and 30 seconds respectively). Several tests, at different pumping and injection rates, were performed in a crystalline rock aquifer at the experimental site of Ploemeur (H+ observatory network).

We show through signal processing how the thermal breakthrough may be extracted thanks to Fiber-Optic distributed temperature measurements. In particular, we demonstrate how detailed distributed temperature measurements were useful to identify different inflows and to estimate how much heat was transported and stored within the fractures network. Thermal breakthrough curves of single well thermal tracer tests were then interpreted with a simple analytical model to characterize hydraulic and thermal characteristics of the fractured media. We finally discuss the advantages of these tests compared to cross-borehole thermal tracer tests.