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Evaluation of the heat-storage capability of shallow aquifers using active heat tracer tests and Fiber-Optics Distributed-Temperature-Sensing

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In the course of the energy transition, geothermal energy storage and heat generation and cooling have proven to be environmental friendly alternatives to conventional energy. However, to ensure sustain usage, the heat transport behavior of aquifers and its distribution has to be studied.

A tool to achieve this is the active heat tracer test, eg. Leaf et al. (2012). If active heat tracer tests are combined with in aquifer heat testing via electric heating-cables, eg. Liu et al. (2013), it is possible to observe heat transport and temperature signal decay without disturbing the original pressure field within the aquifer.

In this field study a two channel High-Resolution-Fiber-Optic-Distributed-Temperature-Sensing and Pt_{100} were used to measure temperature signals within in two wells of 1.4 m distance, where the temperature difference was generated using a self regulating heating cable in the upstream well. High resolution Distributed-Temperature-Sensing measurements were achieved by coiling the fiber around screened plastic tubes. The upstream well was also used to observe heating (ΔT_{max} approx. 24K) and temperature signal decay, while the downstream well was used to observe heat transport between both wells.

The data was analyzed and compared to thermal conductivity of soil samples and Direct-Push (DP) Electrical-Conductivity-Logging and DP Hydraulic-Profiling results.

The results show good agreement between DP data and temperature measurements proving the active heat tracer test is a suitable tool for providing reliable information on aquifer heat-storage capability.

References

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