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Active thermal tracer testing in a shallow aquifer of the Thur valley, Switzerland

Mischa Schweingruber, Márk Somogyvári, and Peter Bayer
ETH Zürich, Department of Earth Sciences, Sonnegstrasse 5, CH-8092 Zürich, Switzerland

Tracer tests are one of the standard methods for investigating groundwater processes. Among the range of different test variants, using heat as a tracer has gained substantial interest during the last decade. Temperature measurements have become essential ingredients for example for characterization of river-aquifer interactions and in the field of geothermics. Much less attention than on natural temperature signals has been devoted to induced synthetic temperature signals, even though it is well known that temperature is an easy to measure, invisible but sensitive system property. Design, application and inversion of such active thermal tracer tests represent one focus of our work. We build up on the experience from related field experiments, where heated water was injected and the propagation of the generated thermal anomaly was monitored. In this presentation, we show the results from first field-testing in an alluvial aquifer at the Widen site in the Thur valley in Switzerland. The thermal evolution of groundwater was monitored in summer 2014 during and after several days of heated water injection. By this test, we want to derive insights into the prevailing hydraulic heterogeneity of the shallow aquifer at the site. The results are used for calibration of a two dimensional hydrogeological numerical model. With the calibrated hydraulic conductivity field, the experiment is simulated and the transient evolution of the heat plume is visualized. Hydraulic heterogeneity is identified as one main factor for lateral spreading of the heat plume. The most important result of the experiment is that the significance of the ambient flow field is very high and even with high pumping rates to establish forced gradient conditions its effect cannot be overridden. During the test, precious technical experience was gained, which will be beneficial for subsequent heat tracer applications. For example, the challenge of maintaining a constant injection rate and temperature could be handled without difficulty, and diurnal temperature fluctuations during injection are minimized.