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# Characterization of an alluvial aquifer with thermal tracer tomography

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In the summer of 2015, a series of thermal tracer tests was performed at the Widen field site in northeast Switzerland. At this site numerous hydraulic, tracer, geophysical and hydrogeophysical field tests have been conducted in the past to investigate a shallow alluvial aquifer. The goals of the campaign in 2015 were to design a cost-effective thermal tracer tomography setup and to validate the concept of travel time-based thermal tracer tomography under field conditions. Thermal tracer tomography uses repeated thermal tracer injections with different injection depths and distributed temperature measurements to map the hydraulic conductivity distribution of a heterogeneous aquifer. The tracer application was designed with minimal experimental time and cost. Water was heated in inflatable swimming pools using direct sunlight of the warm summer days, and it was injected as low temperature pulses in a well. Because of the small amount of injected heat, no long recovery times were required between the repeated heat tracer injections and every test started from natural thermal conditions. At Widen, four thermal tracer tests were performed during a period of three days. Temperatures were measured in one downgradient well using a distributed temperature measurement system installed at seven depth points. Totally 12 temperature breakthrough curves were collected.
Travel time based tomographic inversion assumes that thermal transport is dominated by advection and the travel time of the thermal tracer can be related to the hydraulic conductivities of the aquifer. This assumption is valid in many shallow porous aquifers where the groundwater flow is fast. In our application, the travel time problem was treated by a tomographic solver, analogous to seismic tomography, to derive the hydraulic conductivity distribution. At the test site, a two-dimensional cross-well hydraulic conductivity profile was reconstructed with the travel time based inversion. The reconstructed profile corresponds well with the findings of the earlier hydraulic and geophysical experiments at the site.