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Monitoring temperature changes during heat tracing experiments using electrical resistivity tomography

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Thermal tracing experiments are becoming common in hydrogeology to estimate parameters governing heat transport processes and to study geothermal reservoirs. Electrical resistivity tomography (ERT) has proven its ability to monitor salt tracer tests, but few studies have investigated its performances, both qualitatively and quantitatively, in thermal tracing experiments. In this study, we monitored a heat injection and pumping experiment in an alluvial aquifer using both surface and crosshole ERT. The data sets of the surface profile, located along the main direction of flow, are distorted during injection by an electrical short-circuit through the external pumping-heating-injection experimental set-up. Current is flowing outside the subsurface leading to bad data for electrode dipoles located near the pumping and injection wells. The crosshole ERT panel is perpendicular to the main direction of flow. Difference inversion time-lapse images clearly show a preferential flow path in the bottom of the aquifer related to the presence of a coarse and clean gravel layer. Direct temperature measurements are available in control piezometers during the experiment to validate the ERT-derived temperatures and confirm the spatial pattern of temperature observed with ERT. Breakthrough curves are correctly retrieved in time and difference of 10 to 20% are observed for temperature estimation. The latter requires site-specific petrophysical laws and chemical stability assumptions that must be carefully verified. Our study proves that ERT, especially crosshole ERT, is a reliable tool to follow thermal tracing experiments but also to characterize heat transfer in the subsurface and to monitor geothermal resource exploitations. We also show that surface ERT may be impacted by the survey layout in unsuspected ways.