A salt tracer test monitored with surface ERT to detect preferential flow and transport paths in fractured/karstified limestones

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Abstract

In hardrock aquifers, fractured zones constitute adequate drinking water exploitation areas but also potential contamination paths. One critical issue in hydrogeological research is to identify, characterize and monitor such fractured zones at a representative scale. A tracer test monitored with surface electrical resistivity tomography (ERT) could help delineating such preferential flow paths and estimating dynamic properties of the aquifer. However, multiple challenges such as the lower resolution of surface ERT compared to cross-hole ERT, the finite time that is needed to complete an entire data acquisition or the strong dilution effects exist. We conducted a natural gradient salt tracer test in fractured limestones. To account the high transport velocity, we injected the salt tracer continuously during four hours at a depth of 18 m. We monitored its propagation with two parallel ERT profiles perpendicular to the groundwater flow direction. Concerning the data acquisition, we always focused on the data quality over temporal resolution. We performed the experiment twice to prove its reproducibility by increasing the salt concentration in the injected solution (from 38 to 154 g/l). This paper focuses on how we faced every challenge to delineate a preferential flow and solute transport path in a typical calcareous valley of South Belgium and on the estimation of the transport velocity (more than 240 m/day). In this complex environment, we imaged a clear tracer arrival in both ERT profiles and for both tests. Applying filters (with a cut-off on the relative sensitivity matrix and on the background resistivity changes) was helpful to isolate the preferential flow path from artifacts. Regarding our findings, our approach could be improved to perform a more quantitative experiment. Indeed, with a higher temporal resolution, the estimated value of the transport velocity could be narrowed allowing the estimation of the percentage of tracer recovery.