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3D Electrical resistivity tomography monitoring of an artificial tracer injected within the hyporheic zone

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Due to the high complexity level of hyporheic flow paths, hydrological and biogeochemical processes which occur in this mixing place are not fully understood yet. Some previous studies made in flumes show that hyporheic flow is strongly connected to the streambed morphology and sediment heterogeneity . There is still a lack of practical field experiment considering a natural environment and representation of natural streambed heterogeneities will be always limited in laboratories. The purpose of this project is to propose an innovative method using 3D Electrical Resistivity Tomography (ERT) monitoring of an artificial tracer injection directly within the streambed sediments in order to visualize the water pathways within the hyporheic zone.
Field experiment on a small stream was conducted using a plastic tube as an injection piezometer and home-made electrodes strips arranged in a rectangular form made of 180 electrodes (15 strips of 12 electrodes each). The injection of tracer (NaCl) lasted approximatively 90 minutes, and 24h monitoring with increasing step times was performed. The physical properties of the water are controlled by CTD probes installed upstream and downstream within the river.
Inverse time-lapse tomographs show development and persistence of a conductive water plume around the injection point. Due to the low hydraulic conductivity of streambed sediments (clay and overlying loess), the tracer movement is barely visible, as it dilutes gradually in the pore water. Impact of boundary conditions on inversion results can lead to significant differences on images, especially in the shallow part of the profiles. Preferential paths of transport are not highlighted here, but this experiment allows to follow spatially and temporarily the evolution of the tracer in a complex natural environment .