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2D Electrical Resistivity Tomography surveys optimisation of the solutes transports in porous media.

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Electrical resistivity tomography applied in borehole or cross-borehole is a method often used to follow the invasion process of pollutant [Daily, 1991]. The aim of this work is to test experimentally the electrode arrays and inversion process used to obtain a spatial representation of tracer propagation in porous media. Experiments were conducted in a plexiglas container with glass beads of 166 microns in diameter. The height of the container is 275 mm, its width 85 mm and its thickness 10 mm. 21 electrodes, equally spaced, are placed along each of the lateral sides of the porous medium : these electrodes are used to perform the electrical measurements. The porous medium is lightened from behind and a video camera records the propagation of the fluids. The fluid containing the tracer (i.e the pollutant) is a water solution containing a small amount of dye together with NaCl (0.5g/l up to 2.0g/l). The medium is first saturated by a water solution containing a slight concentration of NaCl so that its density is smaller than the injected fluid. An upward flow is first established, then the denser fluid is injected at the bottom and over the full width of the medium. In this way, the flow is stabilized by gravity avoiding the development of unstable fingers. Still, the fluids are miscible and a mixing front develops during the flow: in the present study, both the determination by optical and electrical imaging of the mean position of the front and its width are of interest. The comparison of the two techniques allows to study the ability of the inversion process to quantify the solute transport. The electrical measurements are acquired by a standard multi electrode system (IRIS Instruments) and the data are inverted with the Res2Dinv software which models the 2D distribution of conductivity contrasts. The obtained bulk conductivity can be related through Archie's law to fluid conductivity by the porosity and the cementation factor which have been experimentally estimated.

At the laboratory scale, the experimental design affects the measurements through boundary effects : we will show that most of these effects can be partially suppressed by using an appropriate inversion method. Since the flow is stabilized by gravity the tracer concentration varies essentially in the vertical direction : the inversion results, for the majority of measurements sequences display homogeneous horizontal conductivity contrasts. Finally, the vertical variations of the conductivity contrasts are found to be well correlated with the video images allowing a quantitative determination of the mixing area. In these conditions it is possible to provide a reliable estimation of the tracer concentration for a fixed front position. However, it's not yet possible to follow the time evolution of the tracer plume because of a lack of temporal resolution. In perspective, we will optimise the acquisition time and determine the best sequences of measurements in order to minimise the number of acquisition in each sequence.