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Electrokinetics dependence on water-content: laboratory and field approach

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Electrokinetics results from the coupling between the water flow and the electrical current through the electrokinetic coefficient. The Self-Potential (SP) method, which is based on this phenomenon, is currently used to investigate shallow transport in the vadose zone. Thus, the understanding of the electrokinetic coefficient behaviour in unsaturated conditions is crucial to interpret such methods. Empirical and theoretical models proposed in the literature to describe this behaviour are still discussed. Consequently, physical processes involved in the electrokinetic coefficient behaviour in unsaturated conditions need to be futher investigate.

We propose here to study the electrokinetics dependence on water content through an experimental approach and the numerical solving of the Richards' equation. We show several continuous records of the electrokinetic coefficient as a function of water saturation. We found that the normalized electrokinetic coefficient behaviour in unsaturated conditions is more complex than it was previously proposed. Indeed, we first observed its increasing with decreasing water saturation. After it reaches a maximum, identified around 80 % of water saturation, it begins to decrease with decreasing saturation. It is an important result since previous works predicted a monotically decreasing of the electrokinetic coefficient with decreasing saturation. We found that the normalized value of the measured electrokinetic coefficient could be two orders of magnitude greater than the classical value in saturated conditions, C_{sat}. We performed several experiments and tried to invert the electrokinetic coefficient data and interpret it in terms of physical processes.

We also propose a field study through several geophysical methods, as electrical resistivity tomography, seismoelectrics, and GPR, in order to combine the results in terms of water-content dependence in soils.