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Contact resistance problems applying ERT on low bulk density forested stony soils. Is there a solution?

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Electrical resistivity tomography (ERT) has often been put forward as a promising tool to quantify soil water and solute fluxes in a non-invasive way. In our experiment, we wanted to determine preferential flow processes along a forested hillslope using a saline tracer with ERT. The experiment was conducted in the Houille watershed, subcatchment of the Meuse located in the North of Belgian Ardennes (50˚1'52.6"N, 4˚53'22.5"E). The climate is continental but the soil under spruce (Picea abies (L.) Karst.) and Douglas fire stand (Pseudotsuga menziesii (Mirb.) Franco) remains quite dry (19% WVC in average) during the whole year. The soil is Cambisol and the parent rock is Devonian schist covered with variable thickness of silty loam soil. The soil density ranges from 1.13 to 1.87 g/cm3 on average. The stone content varies from 20 to 89% and the soil depth fluctuates between 70 and 130 cm.

The ERT tests took place on June 1st 2012, April 1st, 2nd and 3rd 2014 and May 12th 2014. We used the Terrameter LS 12 channels (ABEM, Sweden) in 2012 test and the DAS-1 (Multi-Phase Technologies, United States) in 2014. Different electrode configurations and arrays were adopted for different dates (transect and grid arrays and Wenner – Schlumberger, Wenner alpha and dipole-dipole configurations).

During all tests, we systematically faced technical problems, mainly related to bad electrode contact. The recorded data show values of contact resistance above 14873 Ω (our target value would be below 3000 Ω). Subsequently, we tried to improve the contact by predrilling the soil and pouring water in the electrode holes. The contact resistance improved to 14040 Ω as minimum. The same procedure with liquid mud was then tested to prevent quick percolation of the water from the electrode location. As a result, the lower contact resistance dropped to 11745 Ω. Finally, we applied about 25 litre of saline solution (CaCl2, 0.75g/L) homogeneously on the electrode grid. The minimum value of contact resistance reduced to 5222 Ω. This improved the contact resistance substantially, but complicates the execution of a pulse tracer experiment.

To date we did not find any better solution to this problem and we keep searching a way to improve the contact resistance in stony forested soils with very low bulk density. We would like to exchange on these questions with EGU attendees in order to improve the experimental design or point out a new research path for these specific conditions. This could lead to enhance the use of ERT in soils with low density and high stone content.