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Multi-transmitter/multi-receiver high-speed measurements of soil resistivity and induced polarization – Hydrological application

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Electrical resistivity tomography (ERT) is an adapted tool for the monitoring of soil moisture variations in aquifers (Binley et al., 2015).

Nevertheless, in some specific cases, like for highly permeable soils or fractured aquifers, the measurements from the device can be slower than the water flow through the entire investigated zone. Therefore, the monitoring of such phenomena cannot be performed with classical devices. In such cases, we require a high-speed measurement of soils resistivity.

Since 20 years, the speed of acquisition of the resistivity meters has been improved by the development of multi-channel devices allowing to perform multi-electrode (> 4) measurements. The switching capabilities of the actual devices allow to measure over long profiles up to hundreds of electrodes only using one transmitter.

Based on this multi-receiver technology and on previous work from Yamashita et al. (2013), authors have developed a 250 W multi-transmitter device for the high speed measurement of resistivity and induced polarization. Current is therefore injected simultaneously in the soil through six injection electrodes. The injected current is coded for each transmitter using Code Division Multiple Access (CDMA, Yamashita et al., 2014) so that the different voltages induced by each sources can be reconstructed from the total potential measurement signal at each receiver, allowing to save acquisition time.

The first operational prototype features 3 transmitters and 6 receivers. Its performances are compared to a mono-transmitter device for different sequences of acquisition in 2D and 3D configurations both in theory and on real field data acquired on a shallow sedimentary aquifer in the Loire valley in France. This device is promising for the accurate monitoring of rapid water flows in heterogeneous aquifers.