25-29th September 2016 — 43rd IAH congress — Montpellier, France — CORUM CONFERENCE CENTER

Characterization of subsurface heterogeneity with electrical resistivity tomography: new insights gained on hydrological functions in the Weierbach catchment (Luxembourg)

Abstract n°1777

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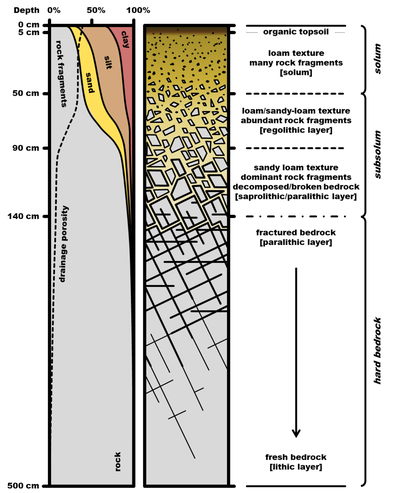
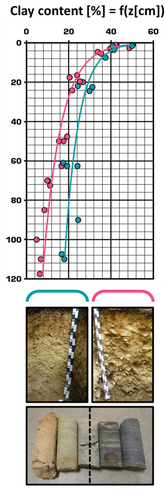
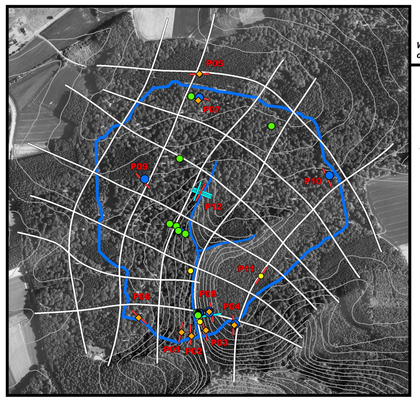
(1) Introduction

The Weierbach is an experimental headwater slate forested catchment. Previous studies have shown that shallow regolith plays a key role in generating runoff in this catchment. However, a detailed characterisation of this hidden compartment has been stymied by the "point-scale" character of conventional intrusive methods. In order to bring new momentum to the understanding of catchment functions of water storage and release, the Weierbach catchment has been extensively investigated using electrical resistivity tomography (ERT). Several kinds of ERT investigation campaigns were strategically deployed to answer different research questions.



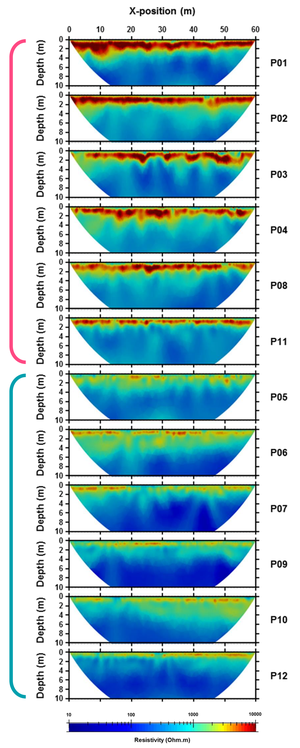


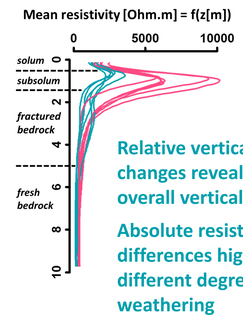


(2) Plot scale [unit of electrode spacing = 0.5 m]

Can ERT help to characterize subsurface structure?
Are there differences from one place to another?

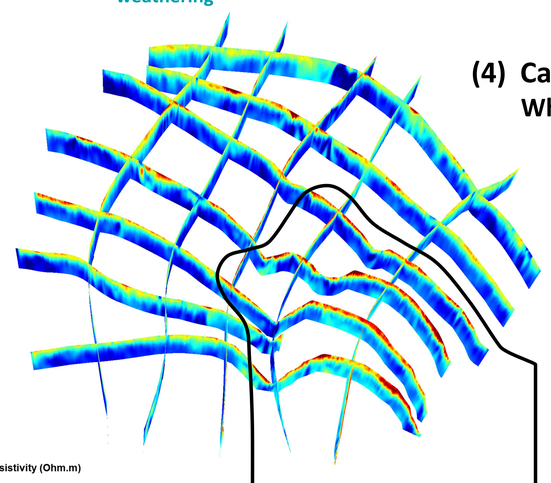
- 12 ERT profiles were distributed over the catchment
- Different relevant geomorphological settings
- Analysis in parallel with drillings and soil pits information





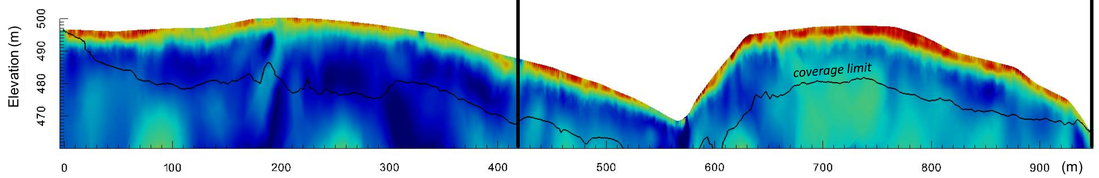
Relative vertical resistivity changes reveal the same overall vertical structure

Absolute resistivity differences highlight different degrees of weathering



Resistivity (Ohm.m)

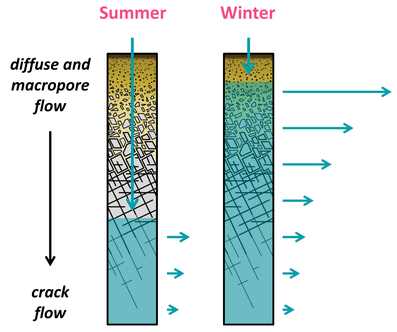
WNW → ESE

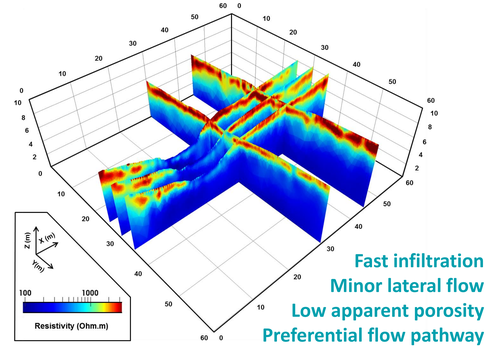


(3) Hot spot [unit of electrode spacing = 0.5 m]

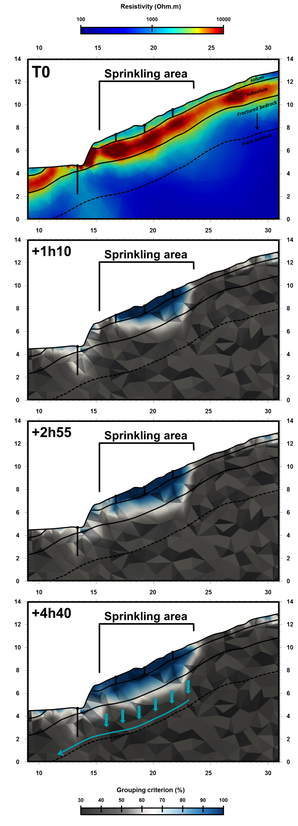
Where is the water stored, how is it released to the stream?

- Time lapse 2D ERT survey [Artificial rainfall hillslope experiment]
- Multiple Inversion and Clustering Strategy (Audebert et al, 2014)
- Pseudo 3D ERT survey [hillslope – riparian zone – stream continuum]





Fast infiltration
Minor lateral flow
Low apparent porosity
Preferential flow pathway
Fresh bedrock impermeable



(4) Catchment scale [unit of electrode spacing = 2.0 m]

What about the homogeneity-connectivity at catchment scale?

- 12 roll-along ERT profiles (cumulative length ~12km)

Delimitation of different chemical weathering areas
Apparent homogeneity and lateral connectivity of the shallow subsurface vertical structure all over the catchment

(5) Conclusion, on going and future work

Through our case study, we illustrate how ERT investigations offer considerable potential for gaining new insights on fundamental catchment functions of water storage and release: plot scale profiles to accurately characterize regolith structure and properties, catchment scale mapping to grasp the overall catchment organisation and connectivity, as well as time-lapse survey to image dominant processes controlling subsurface flow. Our objective now is to gain a more quantitative characterization of the catchment. We are currently working on the automatic delineation of interfaces between the different hydrostratigraphic units across the catchment. Another aspect that we are interested in is to examine possible relationships between resistivity and hydraulic properties of the regolith.

Reference: Audebert et al (2014) Time-lapse ERT interpretation methodology for leachate injection monitoring based on multiple inversions and a clustering strategy (MICS). Journal of Applied Geophysics

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