Master internship (2017 – 6 months)

University Pierre et Marie Curie (Paris, France)

Title: Geophysical interpolation of hydrodynamic properties in the Critical Zone

Keywords: seismic experiments, signal processing, hydrogeophysics, Critical Zone

Scientific context of the internship

As recently stated in ref. [1], « water in the unsaturated vadose zone has an important function for many aspects of life. It is particularly important for plants' growth and serves as a buffer for movement of pollutants from the land surface to the aquifers. The amount of water present in the vadose zone also determines the partitioning of rainfall at the land surface into infiltration and runoff ». But this water content and related physical properties of the soils are characterized by strong spatial and temporal variations mostly driven by weather and anthropogenic activities.

To understand this variability and its link to the stream-aquifer continuum, scientists seek to measure and monitor the soil water content at different scales using a large variety of techniques. Satellite remote sensing using microwave sensors is a well-established technique that has been used to quantify soil moisture in the shallow surface layer (0-5cm) over regional, continental and global scales using a combination of aircraft and satellite platforms. As for in situ monitoring, electrical and electromagnetic methods have shown their efficiency in a large range of applications, but they can occasionally be ineffective in electrically conductive media such as fine-textured soils (e.g., loess, clays).

To overcome these limitations, a geophysical method using the properties of seismic waves – pressure (P) and shear (S) waves – in the subsurface, as modulated by the presence of water, has emerged as a good option [2-7]. The ratio between the P and S wave velocities for a given geological formation has been shown to reflect the amount of water at the surface of the Critical Zone, as measured by in situ observations. However, water content in the subsurface varies on a continuous manner while the inversion of seismic data yields water content at discrete layers, bringing the need to improve inversion models.

Main aim of the internship

In order to address such issues, a collection of time-lapse hydrogeophysical experiments is planned in 2017 on the Orgeval experimental basin (70 km east from Paris, France). This basin is part of the RBV network and has been studied for the last 50 years, with particular focuses on water and pollutant transfer processes occurring at different scales throughout the basin more particularly in the context of the PIREN-Seine research program. The basin drains a stratified aquifer system characterized by tabular layers, well-delineated all over the basin thanks to extensive geological and geophysical surveys including Electrical Resistivity Tomography (ERT), Electrical Soundings (ES), Time Domain ElectroMagnetic (TDEM) soundings and borehole core sampling [8]. Key locations of this basin are monitored with high frequency sampling temperature and pressure sensors in several piezometers, more particularly to focus on stream-aquifer exchanges. One of these « hot spots » will be targeted and extensively studied with the seismic method described above (with equipment provided by the CRITEX program) associated to ERT and « coupled electrical/thermal soundings ». The master student will participate to the experiments and work with the scientific team on the processing of extracted data in order to estimate their complementarity and their ability in providing inputs for hydrodynamic models.

Required skills, qualification and training

We are opened to various education background/profile :

- qualifications or training in Earth sciences are not mandatory but the candidate should be interested in Geosciences;
- required knowledge in physics (mostly continuum and fluid mechanics);

- basics of rock physics/thermal properties of materials could help;
- required knowledge in signal processing;
- basics knowledge in forward modeling techniques and inverse problems theory could help;
- required interest (and motivation) in field experiment ;

Location of the internship

The internship will mainly take place at UMR 7619 METIS [http://www.metis.upmc.fr/en/] a laboratory of the University Pierre et Marie Curie in Paris [http://www.upmc.fr/en/].

The study will be supported by the PIREN-Seine and CRITEX research programs.

Duration and compensation

5 to 6 months compensated with the legal salary, possibly followed by a PhD thesis in the context of a European research program (depending on the candidate profile and admission process).

Supervisors :

- Ludovic BODET : UPMC , UMR 7619 METIS;
- Marine DANGEARD : UPMC , UMR 7619 METIS;
- Fayçal REJIBA : UPMC , UMR 7619 METIS;
- Agnès RIVIERE, Mines ParisTech.

For more information, please contact ludovic.bodet@upmc.fr

If you want to apply please send a CV, motivation letter --and recommendation(s)/referee(s) if possible-- to ludovic.bodet@upmc.fr

References

[1] VZJ Research Highlights. September 06, 2016.

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[6] Pasquet, S., L. Bodet, A. Dhemaied, A. Mouhri, Q. Vitale, F. Rejiba, N. Flipo and R. Guérin, 2015, Detecting different water table levels in a shallow aquifer with combined P-, surface and SH-wave surveys: insights from Vp/Vs or Poisson's ratios, Journal of Applied Geophysics, 113, 38—50.

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