University of Stuttgart
Research Facility for Subsurface Remediation
(VEGAS)

Research Facility for Subsurface Remediation – VEGAS
Universität Stuttgart - IWS • Pfaffenwaldring 61 • 70569 Stuttgart • Germany

Problem Description
B.Sc., M.Sc. Thesis

University of Stuttgart
Institute for Modelling Hydraulic and Environmental Systems (IWS)
Research Facility for Subsurface Remediation (VEGAS)

Directors
Prof. Dr. rer.nat. Dr.-Ing. habil. András Bárdossy
Scientific Director:
Jürgen Braun, PhD
Technical Director:
PD Dr.-Ing. Claus Haslauer

Contact
Pfaffenwaldring 61
70569 Stuttgart • Germany
T +49 711 685-64716
F +49 711 685-67020
e-mail:
claus.haslauer@iws.uni-stuttgart.de
URL: www.iws.uni-stuttgart.de/vegas/

/CPH 20190930
Topic_TDR.docx

Geophysical Measurements (TDR) of Soil Moisture Content at Various Temperatures

Motivation

To achieve the sustainability goals of the German government, seasonal storage of heat is a key component. One possible storage concept is underground thermal energy storage that is fed from solar collectors and that uses ground heat exchangers, most commonly borehole heat exchangers. However, typical borehole heat exchangers are fairly long and are installed below the groundwater level. Therefore, they are subject to water protection regulation, which limits the maximum temperature increase. To avoid negative effects on groundwater resources, we want to investigate the feasibility of underground storage using only very shallow ground heat exchangers in the unsaturated zone above the groundwater table.

Heat injection into the unsaturated zone leads to changes in both temperature and moisture of the soil. In order to investigate the effects of temperature change on soil moisture, and as basis for a numerical model of coupled heat and moisture flow, we will perform laboratory scale experiments in sand-filled containers. These will be equipped with temperature sensors and time domain reflectometry (TDR) probes for computer-controlled measurement of temperature and moisture fields.

As a precursor to these experiments, the (soil-specific) effect of temperature on the TDR measurements has to be investigated.

Time domain reflectometry (TDR) is a geophysical methodology that enables the measurement of bulk electrical permittivity that is typically calibrated to soil moisture content. While this calibration is fairly standard at medium temperatures (≈15°C) and for sandy material, the calibration at higher temperatures (at or above 90°C) and in low-permeable material (clay) is not well understood.

Task

- Familiarize yourself with the existing TDR equipment and python-based data-acquisition and data-analysis codes.
- Setup TDR-based experiments at various moisture conditions, for various soil types, and at various temperatures. This includes both work in setting up laboratory equipment as well as data analysis.

Keywords

- Sustainable remediation
- Geophysics
- Data analysis

Support

We support you with getting started, provide help with programming in python, and getting to know the TDR method. A requirement is that you are interested in learning key concepts of thermodynamics and geophysics. You should be curious and eager to play with data! You will learn key traits that are desired in engineering consultancies.

The student research project will be performed at VEGAS (Research Facility for Subsurface Remediation, University of Stuttgart).

Supervision

PD Dr.-Ing. Claus Haslauer
Samuel Scherrer, M.Sc.
Prof. Sander Huisman

Formulation of Problem / Examiner

PD Dr.-Ing. Claus Haslauer
Prof. Sander Huisman

We'd be happy to hear from you and happily discuss details of the project with you!

Starting date: as soon as possible / to be discussed

Stuttgart, 1-Oct-2019