# Research stay at the University of Wuppertal, Germany

## International fellowship focused on a unique biogeochemical microcosm technique applied to contaminated soil from CZ

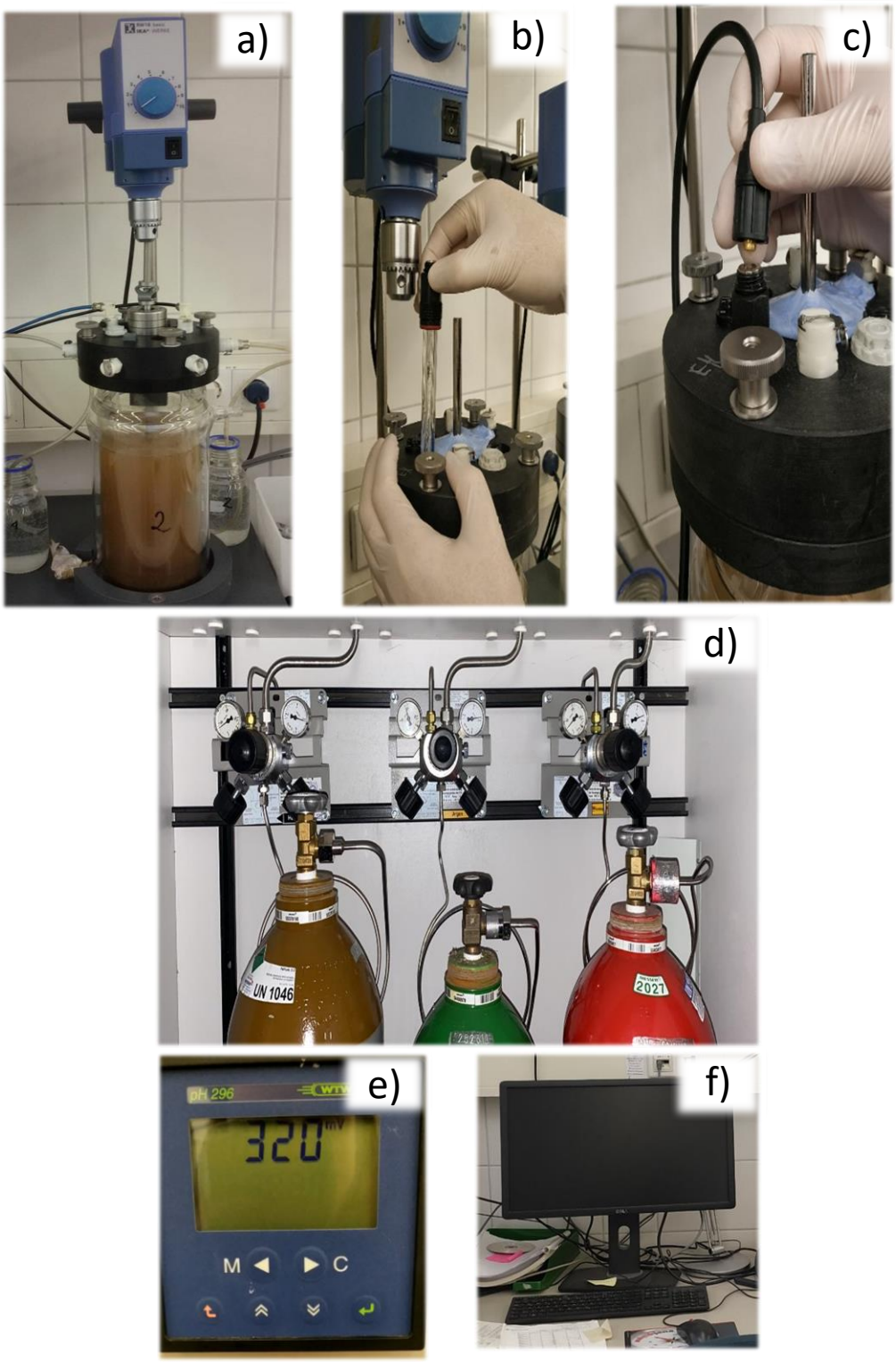
The research stay was realised within the post graduate studies of Aikaterini Mitzia, having a Ph.D. position at CZU Prague, supervised by doc. Mgr. Martina Vítková, Ph.D. The mentor at the University of Wuppertal was Prof. Jörg Rinklebe, who was responsible for the organisation and supervision of the experiment. The duration of the research stay was from October 2019 until February 2020.

Aikaterini Mitzia travelled to Wuppertal, Germany for a fellowship at the University of Wuppertal (*Bergische Universität Wuppertal*). The department of Soil and Ground Water Management of the University of Wuppertal, led by professor Jörg Rinklebe, is specialised in experiments using soils under dynamic redox conditions. The unique microcosm technique which was implemented, has been reported in scientific papers of other researchers (e.g., El-Naggar et al., 2019; Frohne et al., 2011; Rinklebe et al., 2016; Shaheen et al., 2016). Technical details and information about the operation of the microcosm system can be found in Yu and Rinklebe (2011).


*Laboratory of Soil and Ground Water Management of the University of Wuppertal.*

The novelty of the microcosm system is that it enables us to monitor the major factors affecting the biogeochemical processes in soils, i.e., pH, Eh, and temperature. Furthermore, such system allows us to set and continuously control the redox potential (Eh) in the soil samples with the use of $N_2$ and $O_2$ (or synthetic air; mixture of oxygen and nitrogen).

A vessel filled with soil and water (continuously mixed by a stirrer forming a soil slurry) is called a “microcosm” because it can represent the real conditions in flooded soil in a small scale. The vessel is connected to a device which controls the prevailing conditions in the microcosm with the help of a gas-regulating valve which is adding $N_2$ to lower and $O_2$ to increase the Eh.




*Starting and setting the microcosm experiment.* **a)** *airtight glass vessel filled with soil and water connected to an overhead stirrer,* **b)** *a probe is placed inside the vessel,* **c)** *a cable is connected to the probe at one end and the other end is connected to the main operating device,* **d)** *gas bottles are connected to the microcosm device and supply the microcosm with $N_2$ and/or $O_2$ in order to regulate the Eh,* **e)** *the recordings of the probes can be seen on monitors on the device* **and f)** *a data logger is collecting all readings from the probes every 10' and eventually sending them to a computer.*

The soil that was used in this research, comes from a heavily contaminated area near Příbram (Czech Republic). In order to immobilize the present risk metal(loid)s (As, Cd, Pb, Zn), selected soil amendments where applied in certain samples. The main purpose of this experiment was to create the conditions prevailing in flooded soil in a small/laboratory scale and thus understand the behaviour of soil (amended or not) under such conditions. Occasional floods are likely to happen in the field and therefore information about the soil and metal(loid) behaviour under this scenario is important.

Regular samplings were conducted in order to check the metal concentrations in the soil slurry and therefore evaluate the effectiveness of the amendments in response to changing redox conditions. The samples taken from each microcosm were subjected to a number of analyses of liquid (ICP OES, DCN, IC, $Fe^{2+}$, $S^{2-}$, UV) and solid (STEM/EDS, SYNCHROTRON) phase. The handling of the samples was always under limited oxygen environment (i.e. inside a glove box) because the redox potential is significantly affected by the presence of $O_2$ under ambient conditions.

*A glove box where work under no oxygen environment is guaranteed and the samples could be prepared for analyses.*


*Liquid samples with different concentrations of Fe (left) and solid samples for STEM/EDS analysis (right).*

# Accomplishments of the current research:

- ✓ Study the effect of redox conditions on soil characteristics (risk element concentrations, carbon content, $Fe^{2+}$ content etc.)
- ✓ Study the interactions which may occur in the field under flooded conditions
- ✓ Obtain accurate measurements of Eh and pH every 10'
- ✓ Ability to work in no-oxygen environment
- ✓ Ability to control the redox potential
- ✓ Ability to implement the knowledge in the Laboratories of Environmental Geochemistry, CZU Prague

This research stay was funded by Erasmus+ programme and granted a new collaboration between the CZU Prague and the University of Wuppertal. The experiment was concluded successfully and the results from the present research are expected to be published in a prestigious scientific journal.

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*The Wuppertal Schwebebahn (hoovering train); the landmark of the city, operating as a means of public transport since 1901.*

## References for further reading:


El-Naggar, A.; Shaheen, S.M.; Hseu, Z.; Wang, S-L.; Ok, Y.S., Rinklebe, J. (2019): Release dynamics of As, Co, and Mo in a biochar treated soil under pre-definite redox conditions. Science of the Total Environment. 657. 686-695.

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Rinklebe, J., Shaheen, S. M., Schröter, F., & Rennert, T. (2016). Exploiting biogeochemical and spectroscopic techniques to assess the geochemical distribution and release dynamics of chromium and lead in a contaminated floodplain soil. Chemosphere, 150, 390-397.

Shaheen, S. M., Rinklebe, J., Frohne, T., White, J. R., & DeLaune, R. D. (2016). Redox effects on release kinetics of arsenic, cadmium, cobalt, and vanadium in Wax Lake Deltaic freshwater marsh soils. Chemosphere, 150, 740-748.

Yu, K., & Rinklebe, J. (2011). Advancement in soil microcosm apparatus for biogeochemical research. Ecological Engineering, 37, 2071-2075.