Environmental Geophysics:

Imaging of biogeochemical processes at the field scale – advancing the application of geophysical electrical methods for environmental applications

Due to the imminent threat of climate change, to-date environmental investigations demand time- and cost-efficient approaches to characterize in-situ subsurface biogeochemical processes both with high resolution and at the large scale. Such efforts could help us to improve our understanding on a variety of processes ranging from carbon- and nutrient-cycling to the degradation of waste and contaminants. Previous laboratory investigations revealed that geophysical electrical methods, in particular the spectral induced polarization (SIP), are sensitive to relevant microbiological processes. However, taking the observations from the controlled conditions in the lab to the complex environments at the field-scale is still open to debate. One of the main challenges corresponds to the interpretation of the field SIP responses: while geophysical and geochemical laboratory data can help to understand the signatures in well-controlled conditions, the investigated volumes might not be representative for field-scale investigations. Moreover, laboratory data lacks the complexity inherent to real field conditions, commonly related to the superposition of different processes and an important contribution from lithological changes. Hence, the main question remains whether the SIP method is suited for field investigations of natural biogeochemical processes and if it can be discriminated from the variations related to the lithology.

In my presentation, I will address the basic principles of the SIP imaging method, and demonstrate that an adequate design of field surveys, together with a careful processing of the data permit to delineate biogeochemically active zones at the catchment-scale in an imaging framework and in a non-invasive manner. I will address the interpretation of the electrical signatures through the comparison of imaging results collected along different geological settings ranging from landslides to hydrocarbon-contaminated sites. I will also present SIP monitoring results along nanoparticles injections for the degradation of groundwater contaminants to discuss the temporal resolution of the method.