Master Project proposal

Project Details

Title	**Influence of Rock and Fluid Properties on the SIP response**
Principle Supervisor	**Norbert Klitzsch**
Local Supervisor	**Eugen Zibulski**

Spectral induced polarization (SIP) is widely used as a non-invasive, near surface underground mapping technique for exploration and monitoring purposes. SIP measures the frequency dependent complex conductivity of a rock/soil, usually conducted over a frequency range from mHz to kHz.
In spite of being around for over 50 years, fundamentals of the SIP method are yet to be fully understood. Hence, a vast amount of models has been developed over time trying to establish a connection between measurements and rock or pore space properties, e.g., inner surface area and permeability. Yet, existing models are usually constrained by assumptions and simplifications failing to provide a universal foundation.
The full problem involving the electro-migration and diffusion of charges in the pore space can be described by the Nernst-Planck-Poisson equations, a set of coupled differential equations. Recently, a numerical model for solving them was developed in COMSOL Multiphysics®, a powerful finite element simulation toolbox (Bücker et al. 2019). Moreover, Bücker et al. (2019) validated the numerical model using analytical solution for simple geometries.

Tasks:
For your thesis, you will conduct numerical studies with the **COMSOL Multiphysics®**. You will be provided with the validated model for studying the effects of various properties, e.g., surface roughness, spatially variable surface charges, fluid temperature. Afterwards, you interpret the simulated SIP responses and conclude about the impact of your findings on the interpretation of SIP measurements (using established models).

What you need:
- You should have a basic understanding of numerical simulations (finite element/volume methods).
- Experience with Matlab® or Python (or another programming language) would be beneficial.
- Experience with COMSOL Multiphysics® is **not** required.

Skill Profile	0 1 2 3 4 5	comments
Programming		
Fieldwork		
Laboratory work		
Theory		
Processing		
Interpretation		
Geology		

Opportunities provided

		comments
Approved Further Education / Training	No	
Training with particular software	Yes	COMSOL Multiphysics®
Training with particular hardware	No	
Temporary relocation at a research partner	No	
Temporary relocation for fieldwork	No	
Coverage of costs relocation/accommodation/expenses	-	
Local assistance provided	Yes	Visa / housing / financial support
Publication possible	Yes	

Supplementary Documents

Paper by Bücker et al. (2019):
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019JB017679