## Permittivity Measurement & Determination of Moisture Content in Mineral Bearing Soils

**3.45 pm - 5.15 pm**

Dipl.-Ing. Franz Königer (IFG, KIT)

Various dielectric moisture-measuring techniques are employed for the determination of the spatial distribution and temporary alteration of moisture content in soils and mineral mixtures. These dielectric methods are usually divided into capacitive methods and microwave methods.

The capacitive method uses the dependency of a condenser or the detuning of a resonant circuit due to material moisture. Methods using microwaves are based on interaction between material and high-frequency electromagnetic waves.

Conventional measuring methods (TDR, FD, SAR and GPR) and associated sensors will be presented. The advantages and limits of these methods will be shown on geotechnical and technical applications.

Th illustrations will take the already worked out complexity of water binding on mineral surfaces, several relaxation processes and sample size and respectively sample geometry of heterogeneous materials into account.

**Maximum no. of participants: 15**

**Provisional registration** via contact (email) until 31st May 2011 including short description on status and interest of research (abstract)

**Final registration** after confirmation via homepage www.cmm.kit.edu

**Confirmation** follows until **June 15th**

**Participation fee: 250 €**

**PhDs/students: 100 €**

**Venue:**

Akademiehotel Karlsruhe

**Contact**

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Karlsruher Institut für Technologie

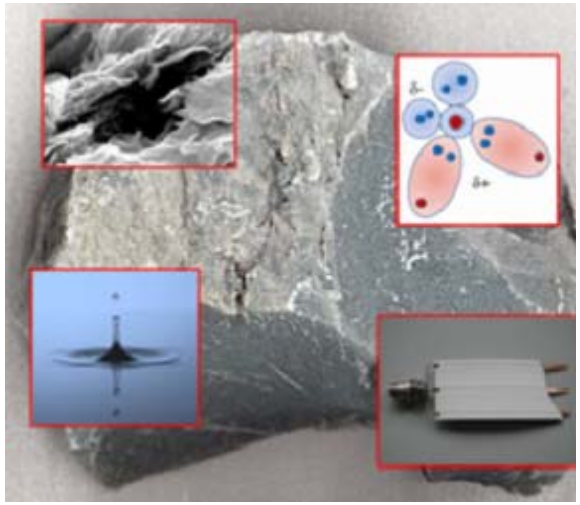
# 1. Autumn School

***Moisture measurement in porous mineral materials***

Basics, methods and techniques for characterization of materials and material moisture

**October 12th , 2011**

Competence Center for Material Moisture (CMM)



## Mineralogical Basics

**8 am - 9.30 am**

PD Dr. Katja Emmerich (CMM, KIT)

Clay minerals absorb water on the surface, within interlayers, in hydrated envelopes of own structural ions but also as crystal water and in hydroxyl groups. Owing to this property, clay minerals are very important as raw materials to research and industry.

In case of rocks we distinguish

- still moist material (in-situ/mining)
- air dry material (for storage or technical applications)
- dry material (after drying at moderate temperatures)

Each of these states is characterized due to the quantity of free water within the pores and also due to absorbed water on the surface or in hydrated envelopes dependent on the phase content and material texture.

Knowledge of the mineral texture as well as the water absorption in minerals and rocks are therefore essential for the understanding of moistening and measuring of the moisture. Owing to their complicated texture, clay minerals dispose of various modes of bound water.

The structural commonalities and differences between swellable and non-swellable clay minerals and laboratory examinations concerning the characterization of clay minerals will be illustrated.

## Hydratation Properties of Clay Minerals

**9.45 am - 11.15 am**

Dr. Eric Ferrage (Uni Poitiers, Frankreich)

Clay minerals contain water in different forms

- structural hydroxyl groups
- absorbed water on (upper) surfaces
- in hydrate envelopes of exchangeable interlayer cations - smectites

0W-, 1W- and 2W-textures develope in dependency of the environmental conditions and the hydration energy of the interlayer cations. These textures can be proved by means of x-ray analysis due to the basic distance of the smectites.

Due to the varying layer charge within a mineral and the heterogeneous occupancy of the interlayers by several cations ($Na^{+}$, $Ca^{2+}$, $Mg^{2+}$) 0W-, 1W- and 2W-textures can occur next to each other. This phenomenon causes both, widening and shifting of the observed basis reflexion.

An exact description of the hydration state is only possible by modeling of the diffractogramms by using mixed layer components.

Furthermore the difference between inner crystalline and osmotic swelling will be highlighted.

## Dielectric Properties of Water and Solutions

**11.30 am - 1 pm**

Dr. Udo Kaatze (Uni Göttingen)

The measuring of the moisture content by means of high frequency electromagnetic waves is based on the coupling of the waves to the electric charge distribution. The coupling to the dielectric properties of the matter and especially to the polarization process of water in an electric field plays an outstanding part due to water having a constant dipole because of its atomic texture.
After an introduction into the dielectric properties of water (relaxation processes in dependency of the frequency), dielectric spectra of aqueous solutions of nonpolar organic molecules, ion solutions and dipolar molecules will be discussed.

## Models for the Permittivity of Soils

**2 pm - 3.30 pm**

Dr. Norman Wagner (MFPA Weimar)

Porous mineral materials, e.g. soils, represent strongly simplified 3-phase systems (solid, pore-solution, air). The obvious differences in the real part of the relative permittivity of free water compared to other phases will be taken into account in applications by means of high-frequency electromagnetic measurements to determine the volumetric water content after the apparent permittivity of the soil was measured with empiric and semi-empiric approaches.
In terms of the modeling of the effective complex permittivity of porous mineral material, specific approaches, laws of mixtures, relaxation models and numerical rules of mixtures will be illustrated.