Schedule

Monday, 18th September

9.00 am – 9.30 am	**Introduction**
9.30 am – 11.00 am	**Clay Mineralogy and Mineralogy of Building Materials** PD Dr. Katja Emmerich (CMM, KIT)
	Coffee break
11.30 am – 1.00 pm	**Hydration Properties of Clay Minerals** Eric Ferrage (University Poitiers)
	Lunch
2.00 pm – 3.30 pm	**Dielectric Properties of Water and Solutions** Richard Buchner (University Regensburg)
	Coffee break
4.00 pm – 5.30 pm	**Models for the Permittivity of Soils** Norman Wagner

Tuesday, 19th September

8.30 am – 10.00 am	**Sensors and Moisture Measurement in Soils, Barriers and Building Materials** Franz Königer (CMM, KIT)
	Coffee break
	Keynotes with discussion
10.30 am – 11.30 am	**Water Content in Soils** Wolfgang Durner (University Braunschweig)
11.30 am – 12.00 am	**Discussion**
	Lunch break
1.00 pm – 2.00 pm	**Water Content in Clay Rock and Implications for Radioactive Waste Repositories** David Jaeggi (Swisstopo)
2.00 pm – 2.30 pm	**Discussion**
	Coffee break
3.00 pm – 4.00 pm	**Water Content in Building Materials** Sabine Kruschwitz (BAM Berlin)
4.00 pm – 4.30 pm	**Discussion**
4.30 pm – 5.00 pm	**Feedback**

Maximum no. of participants: 15

Provisional registration via contact (email) until 31st May 2017 including short description on status and interest of research (abstract).
Final registration after confirmation at our homepage www.cmm.kit.edu

Confirmation follows until June 20th 2017

Participation fee: 350 €
PhDs/students: 180 €

Venue: AkademieHotel, Am Rüppurrer Schloss 40
76199 Karlsruhe

For room booking contact:
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Contact
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4. Autumn School

Moisture measurement in porous mineral materials

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

September 18th – 19th, 2017*
Karlsruhe, AkademieHotel

*) preceding CMM Conference, 20th – 21th Sept. 2017

COMPETENCE CENTER FOR MATERIAL MOISTURE (CMM)

Clay Mineralogy and Mineralogy of Building Materials
PD Dr. Katja Emmerich (CMM, KIT)

The moisture of mineral materials depends on mineralogy and processes. The main processes are hydration of minerals and hardening of construction materials. Similarities and differences of structure and water binding of clay minerals, other soil minerals, natural stones and cement minerals together with laboratory methods for material characterization and calibration of moisture measurements will be presented.

Hydratation Properties of Clay Minerals
Dr. Eric Ferrage (Uni Poitiers, Frankreich)

Clay minerals contain water in different forms (structural hydroxyl groups, surface absorbed water and hydration shells of exchangeable interlayer cations in swellable clay minerals). 0W-, 1W- and 2W states develop in dependency of the environmental conditions and the hydration energy of the interlayer cations. These hydration states can be proved by means of X-ray analysis due to the basic distance of the smectites. Several hydration states can occur next to each other. An exact description of the hydration state is only possible by modeling of the diffractograms by using mixed layer components. Furthermore, the difference between inner crystalline and osmotic swelling will be highlighted.

Dielectric Properties of Water and Solutions
Richard Buchner (University Regensburg)

Moisture content measurements by means of high frequency electromagnetic waves are based on the coupling of the waves to the electric charge distribution of the molecular building blocks constituting the sample. Due to the permanent dipole moment of water molecules and enhanced by the peculiar structure of this liquid, polarization processes and thus the resulting dielectric properties are not only very sensitive to the amount of water present but also to the environment of these molecules. After an introduction into the dielectric properties of water and its coupling to molecular-level dynamics, the effect of solutes on the dielectric spectra will be discussed for aqueous solutions of electrolytes and of nonpolar and polar organic molecules.

Models for the Permittivity of Soils
Dr. Norman Wagner

Porous mineral materials, e.g. soils, represent strongly simplified 3-phase systems (solid, aqueous pore-solution, air). The obvious differences in the real part of the relative permittivity of free water compared to other phases is used in applications by means of high-frequency electromagnetic measurement techniques to determine the volumetric water content of a porous mineral material with empirical or semi-empirical approaches from measured apparent permittivity. However, relaxation effects due to interface processes disturb the quantification of the water content with these techniques. In terms of modeling the effective complex permittivity of porous mineral materials, besides empirical and semi-empirical approaches, mixture equations as well as broadband relaxation models will be illustrated and their advantage and drawbacks will be discussed.

Sensors and Moisture Measurement in Soils, Barriers and Building Materials
Dipl.-Ing. Franz Königer (CMM, KIT)

Various dielectric moisture-measuring techniques are employed for the determination of spatial distribution and temporary variation 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 capacitor 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. The illustrations will take into account the already worked out complexity of water binding on mineral surfaces, several relaxation processes and sample size and, respectively, sample geometry of heterogeneous materials.

Keynotes with discussion

Keynotes will highlight the importance of water content and moisture measurement in different fields of science and applications. Discussion about needs and challenges of accurate measurement of moisture including calibration of in-situ and remote measurements in dependence of material is strongly encouraged.

Water Content in Soils
Wolfgang Durner (University Braunschweig)

Soil water affects biological, chemical and transportation processes as well as mechanical properties of soils. This presentation highlights specific aspects of soil water, its modelling and measurement.

Water Content in Clay Rock and implications for Radioactive Waste Repositories
David Jaeggi (Swisstopo)

A comprehensive overview about the dependency of THM properties of the potential host rock formation Opalinus Clay and geotechnical barriers (bentonite buffer and sealing systems) upon the initial moisture content and its changes will be provided.

Water Content in Building Materials
Sabine Kruschwitz (BAM Berlin)

Monitoring of moisture in historical buildings and restoration concepts together with regulations and challenges for moisture measurement in modern buildings will be discussed.