INTREE
Graduate School of Research

MSc in Earth and Planetary Science, Environment

Speciality:
Mineral Materials / International MSc in Advanced Clay Science

Contact: Patricia Patrier Mas
(Poitiers University – IC2MP Institute)
patricia.patrier@univ-poitiers.fr

A network of professionals, teachers and researchers

To help you build your future

Poitiers University, Grenoble Alpes University, Lorraine University, Haute Alsace University, UPMC Paris, Clermont Ferrand BP University, ENS Paris, Limoges University, Technical University of Crete, Le Louvre Paris, French Geological Survey, ORANO, TOTAL, IFSTTAR, Federal University of Rio Negro, Tel Hai College, Federal University of Rio Grande do Sul...

A multidisciplinary master's degree for … a wide range of opportunities

Expertise in many analytical tools for mineral and geomaterials characterization

Three periods of internship in privates companies or academic laboratories (in France or abroad)

Linked to the industrial demand (TOTAL, ORANO, LAFARGE HOLCIM, IMERYS, IFSTTAR, IPSEN, INRA, LA MANCHA, ERM…), associated with a wide range of private and academic laboratories

An international training course

A national and international recognition

Labellisation Erasmus Mundus (2010-2015)

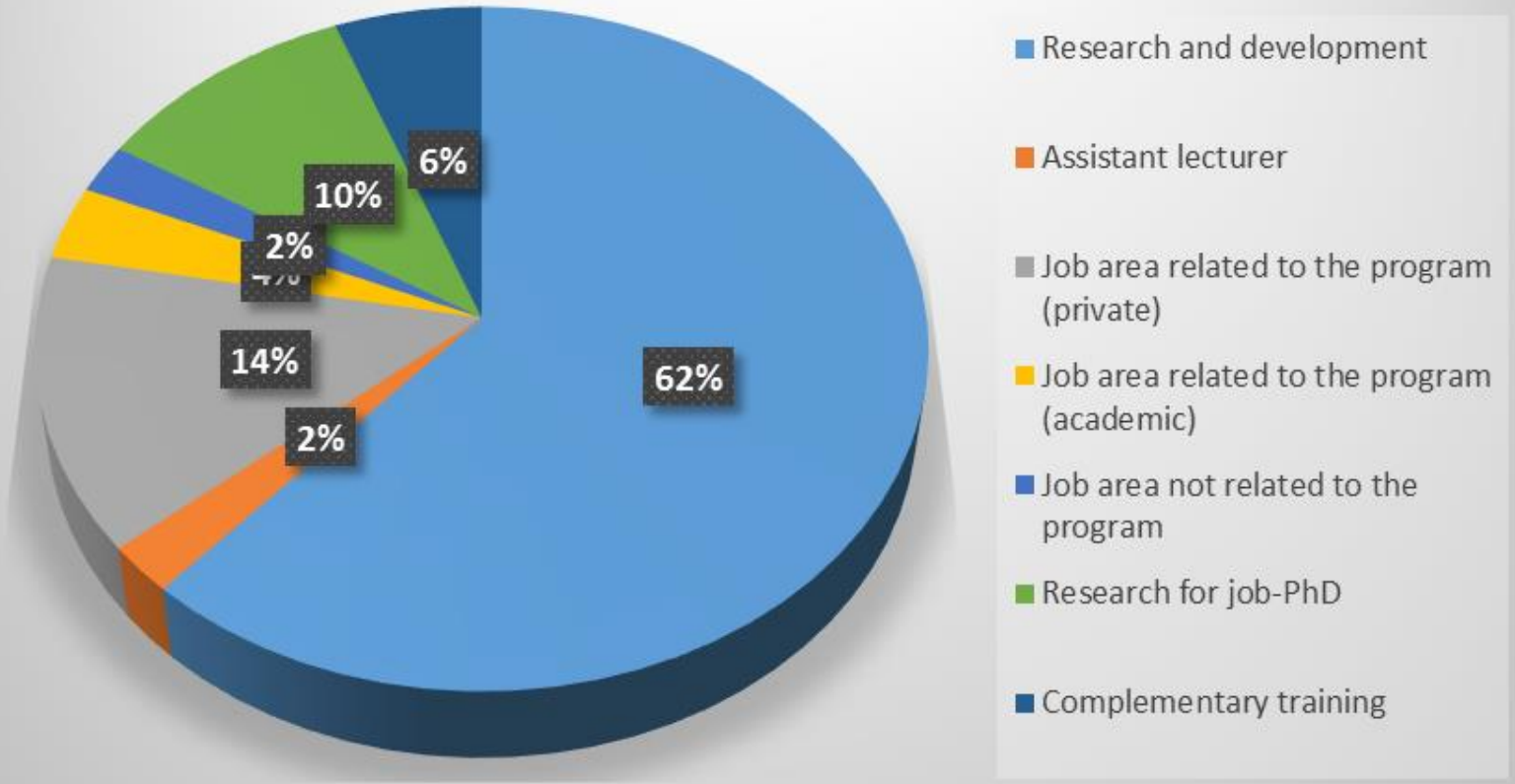
Labellisation EUR « Ecole Universitaire de Recherche » (IntREE) (2020-)

Student awardees at the last Euroclay meeting (Edinburgh 2015), from left to right: Liva Dzene, Carmen Ciotonea, Fabien Baron, Valentin Robin. (photo K Murphy - S Hillier)

Opportunities

- Analysis / Research / Development laboratories – Scientific instrumentation
- Mineralogist
- Geologist, mining geologist, exploitation of mineral/energetic resources (deposits, quarries), remediation
- Material Engineer (industrial minerals, ceramics, cement, geopolymers, eco-materials and nanomaterials)
- Geotechnical Engineer
- Soil expert, polluted sites and soils
- Geoarcheologist
- Protection of natural and cultural heritage
- Researcher / lecturer
- Scientific journalism

Position - 6 months after graduation



Programme

Year 1

- Water/ rock interactions
- Minerals/Materials characterization techniques – Part 1
- Soil science – current research and development on soils components
- Paleo-conditions marker minerals in sub-surface geological environments
- EUR IntREE Common course unit 1
- EUR IntREE Soft skills 1 : Foreign Language and Scientific communication
- Resarch project
- Minerals/Materials characterization techniques – Part 2
- Microstructure and imaging of materials
- Solid/solution interface
- Organization of clay suspensions
- EUR IntREE Common course units 2
- EUR IntREE Soft skills 2
- First year internship

Year 2

- Water/ rock interactions
- Industrial clays – Geomaterials
- Clays in cultural heritage
- Functionalized layered materials/minerals and bio-interfaces
- Environmental Civil Engineering: geotechnical hazards and sustainable applications of clay geomaterials
- Molecular Modeling
- EUR IntREE Common course units 3
- EUR IntREE Soft skills 3
- EUR Practicum
- Master thesis internship

Course unit: **Water/ rock interactions**

Semester 1 - ECTS credits: 3 – 10h lecture, 7h tutorials, 8h practicals - Teaching language: English

First Year

This unit is devoted to give basic tools of thermodynamic in order to predict chemical reactions between a given fluid and minerals and/or natural rocks. We focus on dissolution/precipitation reactions due to their strong influence on the transfer properties of rocks and aquifers. Redox interactions are also discussed in this unit.

Objectives

In the context of dissolution/precipitation interactions, the first objective will be to predict the saturation state of a natural water with respect to a mineral, especially by considering the salinity of the geological fluid. Then, these notions will be applied to rocks in order to predict the stability of the minerals presented inside with respect to a given fluid. One of the main objectives is the construction of activity diagrams generally used to predict fluid/rocks interactions at equilibrium (mineral solubility versus pH, T or salinity; Korjinski diagram; Eh/pH graphics).

Content

- Chemical composition of natural waters (water facies, charge balance, graphic representation of hydro-chemical analyses)
- Basics of thermodynamics applied to chemistry of natural waters
- Saturation state of a given water (dissolution/precipitation equilibrium) and aqueous speciation calculations
- Mineral stability versus chemical composition of water
- Construction and interpretation of activity diagram : prediction of the chemical composition of a water at equilibrium with a rock
- Eh/pH diagram : application to retreatment of mine wastes and/or polluted waters
- Practical works: (i) dosage of major cations in natural waters, (ii) speciation calculation of sea water with hydro-chemical software (iii), assessment of solubility of a mineral versus pH and solubility product from an experimental point of view.

Prerequisites

- Mineral definition – Main terrestrial rocks minerals
- Main ions in natural waters

Knowledge/skills acquired

- Calculation of the charge balance of a given water
- Calculation of the saturation state of a given water with respect to minerals and prediction of its aggressiveness with respect to a mineralogical assemblage
- Knowledge of the difference between aqueous species and dissolved elements
- Know « how to construct » activity diagrams
- Basic measurements in spectrophotometry

Assessment

Continuous assessment

Practical work report

Bibliography

Michard Gil, 2002. Chimie des eaux naturelles : principes de géochimie des eaux. 462 p. Edition PUBLISUD.

Nordstrom D.K. and Munoz J.L., 1994. Geochemical Thermodynamics. Second Edition, the Blackburn Press.

Head of the training unit

Emmanuel Tertre,

emmanuel.tertre@univ-poitiers.fr

Main contributors

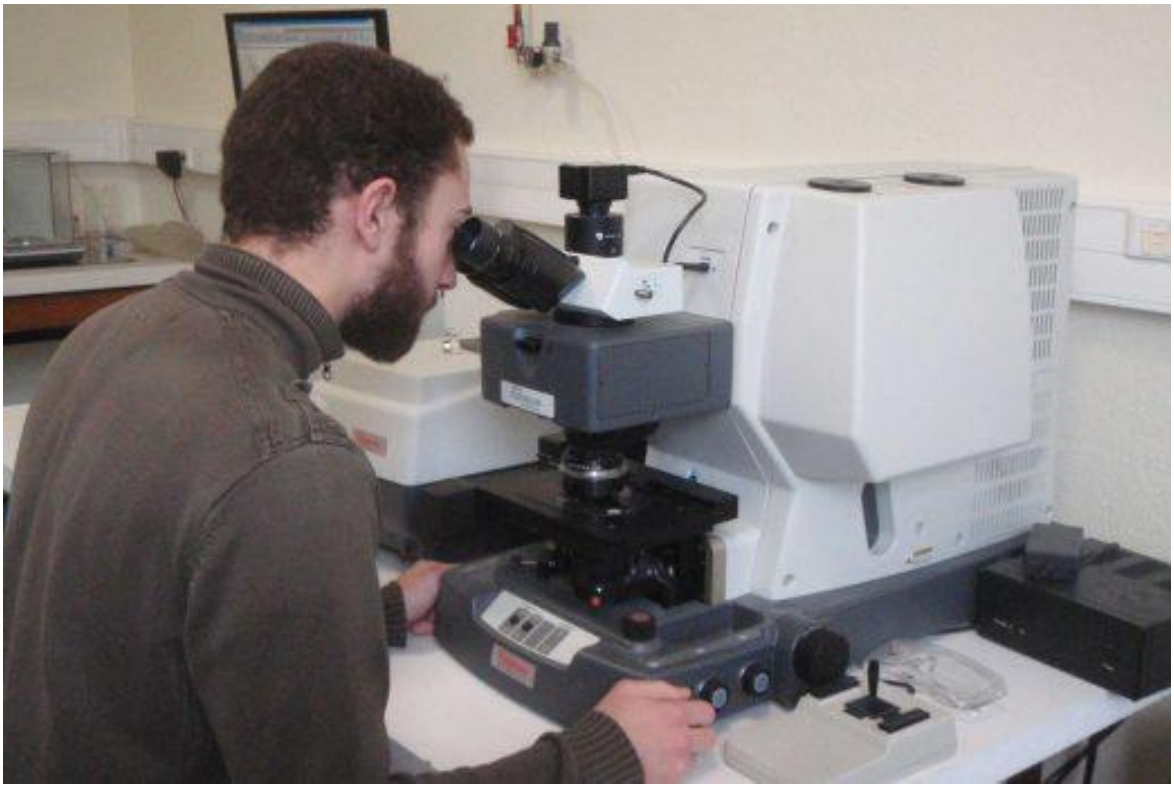
Emmanuel Tertre, Poitiers University (IC2MP Institute)

Aude Naveau, Poitiers University (IC2MP Institute)

Course unit: **Minerals/Materials characterization techniques – Part 1**

Semester 1 - ECTS credits: 3 - 19h lecture, 6h tutorials - Teaching language: English

First Year



Based on examples and applications to clays and other minerals, we will see how to use a wide range of techniques dedicated to solid characterization (spectroscopy, diffraction) to better analyze, understand and model mineral structures. The module will mainly rely on the study of the structures and crystal chemistry of lamellar materials and more specifically clays. The great chemical and structural diversity of these minerals makes them complex subjects of study, thus allowing us to understand the analysis capabilities and limitations of the different instruments with a complex natural material.

Objectives

This module, in two parts, is intended for all students who, in their professional life, will be confronted with scientific instrumentation and/or the characterization of natural/synthetic material using physical methods.

The first part of this module will focus on the theoretical bases as well as crystal-chemical solid analysis techniques.

Content

1) Crystallography – Diffraction Basics:

X-ray diffraction is one of the most popular techniques for solid characterization. It allows the identification of the (known) crystalline species present in a sample as well as their quantification. It also allows the determination of unknown structures or the fine characterization of crystal-chemistry properties of natural or synthetic crystalline materials. Diffraction requires basic crystallographic knowledge to be correctly interpreted.

Theoretical basis of crystallography:

- First principles: Symmetries, Space groups.

Theoretical basis of diffraction (X-rays) and usual applications (phase identification):

- Crystalline networks, reciprocal networks, indexes.
- Theory of diffraction (structure factor, form factor)
- Interpretation of diffractograms (data reading, phase identification)
- Parameters affecting diffraction
- Specifications of lamellar materials

2) Infrared spectroscopy:

This part of the module is designed to train students in the use, analysis and understanding of infrared spectra. This crystal-chemical characterization technique is based on radiation/material interaction. The courses will also address the interactions between mineral and organic matter.

- Theoretical basis specific to infrared spectroscopy
- Spectrum acquisition
- Analysis of experimental data and interpretations.
- Crystal-chemistry of mineral materials.

3) Introduction to Nuclear Magnetic Resonance

Such technique allows to obtain information on the order around specific atoms (H, Na, Al for solid NMR) and complementary atoms. On the other hand, the possibility to probe H becomes interesting for interactions between mineral and organic matter. The NMR teaching will be complemented by a mineral/infra-red interaction component, providing a comprehensive and coherent view of the OM studies.

4) X-Ray fluorescence and TDG-DTA

Illustration of the first chemical studies through analysis of samples by X Ray fluorescence.

The results of chemical analyses by X Ray fluorescence will be supplemented by the information provided by the thermal analysis TGA-DTA for species not easily detected by the first techniques (H_2O, OH^-, CO_3^{2-})

Prerequisites

- Bases of mineralogy
- Basics in Mathematics, Chemistry and Physics (general science course)

Knowledge/skills acquired

- Solid knowledge of the crystalline structures and crystal-chemistry of lamellar mineral materials.
- Complete vision of the analysis of a mineral through different techniques (diffraction, spectroscopy).
- Ability to manage the entire chain of analysis, from sample preparation and data acquisition to final analysis and understanding radiation/material interactions.
- Ability to process a signal (XRD, FTIR...).
- Ability to extract the relevant crystal-chemical information while being aware of the limitations of their analyses.

Assessment

Final exam

Continuous assessment

Head of the training unit

Baptiste Dazas : baptiste.dazas@univ-poitiers.fr

Bruno Lanson : bruno.lanson@univ-grenoble-alpes.fr

Main contributors

Fabien Baron, Poitiers University (IC2MP Institute)

Karine Vigier, Poitiers University (IC2MP Institute)

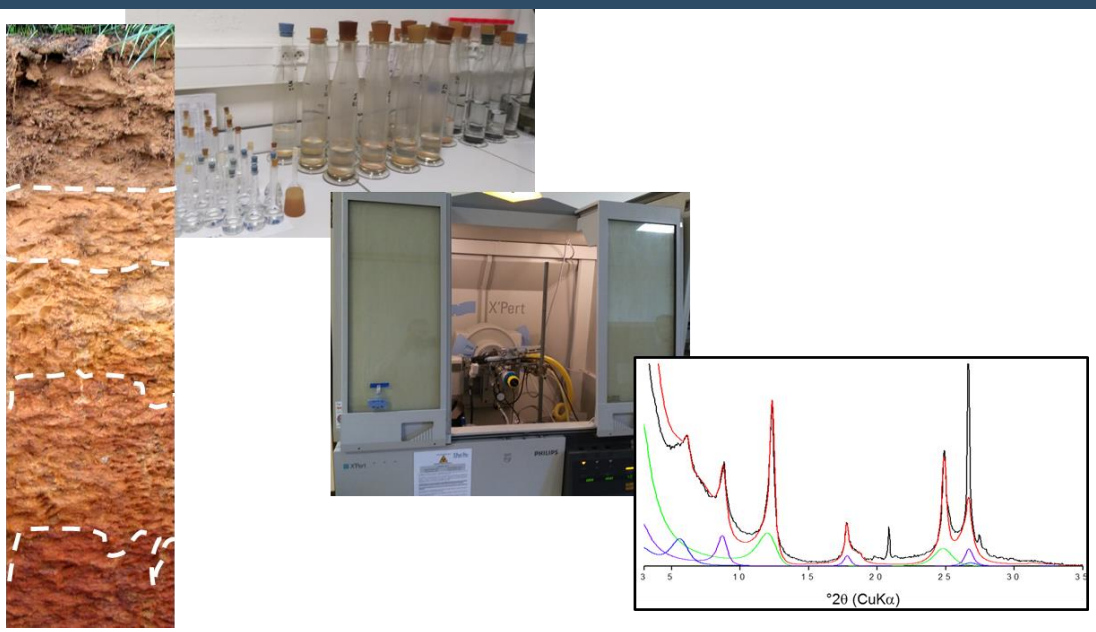
Dimitri Prêt, Poitiers University (IC2MP Institute)

Claire Marichal Westrich, Haute Alsace University (IS2M Institute)

First Year

Course unit: **Soil science – current research and development on soils components**

Semester 1 - ECTS credits: 3 - 15h lecture, 10h tutorials - Teaching language: English



This course concerns the study of soil mineralogy and the key role played by minerals in the current worldwide challenges in soil science research. The first part of the teaching is focused on the methodology for the identification of soil minerals. The second part addresses the role of soil minerals through three worldwide challenges in soil science: feeding resources, carbon sequestration and the migration of contaminants.

Practical skills developed in the research laboratory focus on the main steps leading to the identification of soil minerals: sample preparation, data recording and interpretation of the data.

Objectives

One of the objectives of this course unit is to introduce the key role of mineralogy in the main current challenges in soil science research (feeding resources, carbon sequestration and the migration of contaminants). The second objective is to train the student to implement and optimize methodologies for the characterization of soil minerals.

Content

•General introduction on soil mineralogy. This first course will introduce the context as well as the goal of the module for students. Basics of coordination chemistry and solid chemistry will be introduced. These bases will be applied to minerals and more specifically to the crystal chemistry of clays. These lectures will ultimately allow us to understand the use of the different techniques applied to clay minerals.

•Advanced method for the identification of soil minerals based on the X-ray diffraction profile modelling approach.

•Identification and role of soil minerals in the context of agricultural and forest soils.

•Role of mineralogy for the soil carbon sequestration.

•Role of mineralogy for the migration of contaminants.

Prerequisites

•Course unit : Minerals/Materials characterization techniques

Knowledge/skills acquired

•Implementation and optimization of methodologies at the laboratory for the characterization of soil minerals.

•Expertise concerning the identification of soil minerals and their role for soil carbon sequestration, feeding resources and migration of contaminants.

Bibliography

•Velde B.B., Meunier A. 2008. The Origin of Clay Minerals in Soils and Weathered Rocks. Springer.

Assessment

Final exam

Continuous assessment

Head of the training unit

Fabien Hubert, fabien.hubert@univ-poitiers.fr

Main contributors

Fabien Hubert, Poitiers University (IC2MP Institute)

Baptiste Dazas, Poitiers University (IC2MP Institute)

Pierre Barré, ENS Paris (Geology lab)

Samuel Coussy, BRGM Orléans

Course unit: **Paleo-conditions marker minerals in sub-surface geological environments**

Semester 1 - ECTS credits: 3 - 14h lecture, 4h tutorials, 6h practicals - Teaching language: English

First Year

The sub-surface geological systems of the continents (diagenetic and hydrothermal series) are complex. These systems can be extremely dynamic over time and in space, in response to changes in environmental conditions (temperature, fluid composition, tectonic activity, etc.). In the case of sub-surface rocks, alteration due to circulation of crustal fluids linked to sediment burial, tectono-magmatic/metamorphic activity causes extensive changes in the mineralogical composition and texture of the rocks. These changes are at the origin of the formation of the main deposits that constitute the resources of metallic raw materials, minerals and fossil or renewable energy necessary for the economic development of our societies (hydrocarbons, uranium, geothermal reservoirs...).

Objectives

In each geological system considered, interventions will focus on the use of the properties of altered/transformed rocks and clay minerals as markers for the evolution of fluid/rock interaction conditions. Clay minerals are particularly reactive and important actors of fluid-rock interactions. They have the ability to archive the history of geological formations in reaction mineral sequences or the intrinsic properties of crystals. They will be therefore used as potential markers of the chemical and physical conditions essential for understanding the functioning of natural systems.

Content

•Several sub-surface geological environments will be addressed

•Geothermal fields and continental hydrothermalism

•Sedimentary basins and the silicoclastic diagenesis

•This module includes sampling (field work and/or lab) and integrated laboratory study of natural samples (use of different petrography-mineralogy tools).

Prerequisites

•Basic knowledge of petrology/mineralogy.

•Minerals/Materials characterization course units of semester 1 and 2

Knowledge/skills acquired

•Up-to-date basics on the petrology of alterations and mineralogy of clays in the sub-surface context

•Ability to conduct representative and relevant sampling

•Implementation of the techniques studied during semesters 1 and 2: sample preparation, analysis and interpretation in terms of paleo conditions.

•Ability to format results

Assessment

Final exam

Continuous assessment

Head of the training unit

Patricia Patrier, patricia.patrier@univ-poitiers.fr

Main contributors

Patricia Patrier, Poitiers University (IC2MP Institute)

Jean Pierre Girard, TOTAL Company

Sophie Billon, Poitiers University (IC2MP Institute)

Abder EL Albani, Poitiers University (IC2MP Institute)

EUR InTREE Common course units 1 :

Semester 1 - ECTS credits: 3 - 32h lectures - Teaching language: English

First Year

INTREE
Graduate School of Research

Interfaces for aeronautic energy and environment

These course units are IntREE specific cross-disciplinary course units. Therefore, they are attended by all registered EUR IntREE student (including all IMACS students).

Objectives

The EUR "interfaces" related courses available all along the student's academic progress provide students with a sound practical, methodological and theoretical grounding in interfaces problems, in relation to the scientific project objectives.

The objective of common courses is to introduce advanced interfaces-related courses and favoring transdisciplinary in addition to core curriculum vitae.

Content

1) Radiation/Matter interaction: The basics of the interaction between electromagnetic radiation and matter are discussed: elastic interaction, Compton effect, photoelectric effect. The phenomena of production and absorption of X-Ray are presented. The course then focuses on the elastic scattering of X-Rays via the kinetic theory of X-Ray diffraction. Based on the knowledge of crystallography, the objective of the course is to acquire the bases of the quantitative study by X-Ray diffraction of the microstructure of crystalline materials.

2) Electron matter interaction: Electron microscopy and applications . Brief history of microscopy. Reminders of the theoretical aspects of electron matter interaction. Electron microscopy, principles and equipment (Electron optical elements for scanning microscope, SEM, and transmission electron microscope TEM). SEM and its applications in imaging. X-ray microanalysis by electron probe, principle and instrumentation. Microanalysis and its applications.

3) Surface chemistry: Surface thermodynamics (e.g. characteristic thermodynamic quantities of adsorption). Solid-gas interfaces (role of adsorption, types of adsorption, adsorption isotherms, effects of pressure and temperature). Solid-liquid interfaces (contact angle surface tension/wettability, Langmuir and Langmuir-Blodgett films, electrostatic forces (e.g. electric double layer), self assembling systems. Applications of surface chemistry in heterogeneous catalyst technology, semi-conductor-based technology, medical technology, anticorrosion and lubricant technology, and nanotechnology will be highlighted in seminars.

4) Digital and programming tools (part 1)

Prerequisites

- BSc of Sciences

Assessment

Continuous assessment (written exams in class room)

Contributors

Pierre Olivier Renault, Poitiers University (PPRIME Institute) (1)
Ludovic Thilly, Poitiers University (PPRIME Institute) (2)
Dimitri Prêt, Poitiers University (IC2MP Institute) (2)
Ludovic Thilly, Poitiers University (PPRIME Institute) (2)
Thomas Belin, Poitiers University (IC2MP Institute) (3)
Aurélien Habrioux, Poitiers University (IC2MP Institute) (3)
Julien Godet, Poitiers University (IC2MP Institute) (4)

EUR InTREE Soft skills 1 : Foreign Language and Scientific communication

Semester 1 - ECTS credits: 3 - 8h lecture, 22h tutorials - Teaching language: English

First Year

Objectives

The aim is to provide the student with communication tools and approaches that will be necessary during the training period (during periods of internship in a company/laboratory or for the projects he/she will have to carry out) as well as during his/her professional career.

Continuing development of comprehension and expression skills in English with additional emphasis on specialized technical vocabulary relevant to discipline.

Content

1) Scientific communication :

The course provides a review of the principles and practice of the various modes and forms of scientific communication including scientific papers, technical reports, poster and oral presentations. The aim is to provide the student with communication tools and approaches that will be necessary during the training period (during periods of internship in a company/laboratory or for the projects he/she will have to carry out) as well as during his/her professional career.

2) English :

Continuing work on grammar and linguistic structures, in class and autonomously, texts relevant to discipline (comprehension and expression), oral comprehension using video documents in the language laboratory, production of film on chosen subject relevant to discipline and continuing oral interaction work in class...

Prerequisites

- Minimum required level of English: Level B1+

Knowledge/skills acquired

- Mastery of traditional office automation tools for writing and presenting data
- Ability to manage time in an oral presentation
- Ability to collect, critically evaluate, synthesize and report on a particular subject according to a particular standard (bibliographic synthesis...)
- Ability to format results and communicate through various media (oral presentations, writing reports, posters, etc.).
- Ability to present/write a research project according to the standards requested by the company.
- Awareness of plagiarism regulations.
- Practical communication, comprehension and expression in English

Assessment

Continuous assessment

Main contributors

Christophe Tromas, Poitiers University (PPRIME Institute) (1)
Andrew King, University of Poitiers (2)

First Year

Course unit: **Research project**

Semester 1 - ECTS credits: 12 – 2,5-3 days/week - Teaching language: English

Practicals works in laboratory. The students will spent about 2,5/3 days a week on their research training in their chosen field of research. This first project starts in October and runs until the end of the first semester.

Objectives

The objective is to promote the learn-by-doing through immersion in the laboratory (IC2MP lab, Geosciences team: HydrASA) and through the supervised use of main mineral characterization techniques.

Prerequisites

- Common courses on e-matter and radiation-matter interactions
- Bases in mineralogy

Knowledge/skills acquired

- Reading key publications
- Developping a network of colleagues
- Learning the basic experimental and simulation techniques
- Learning to write a scientific report

Assessment

Poster presentation

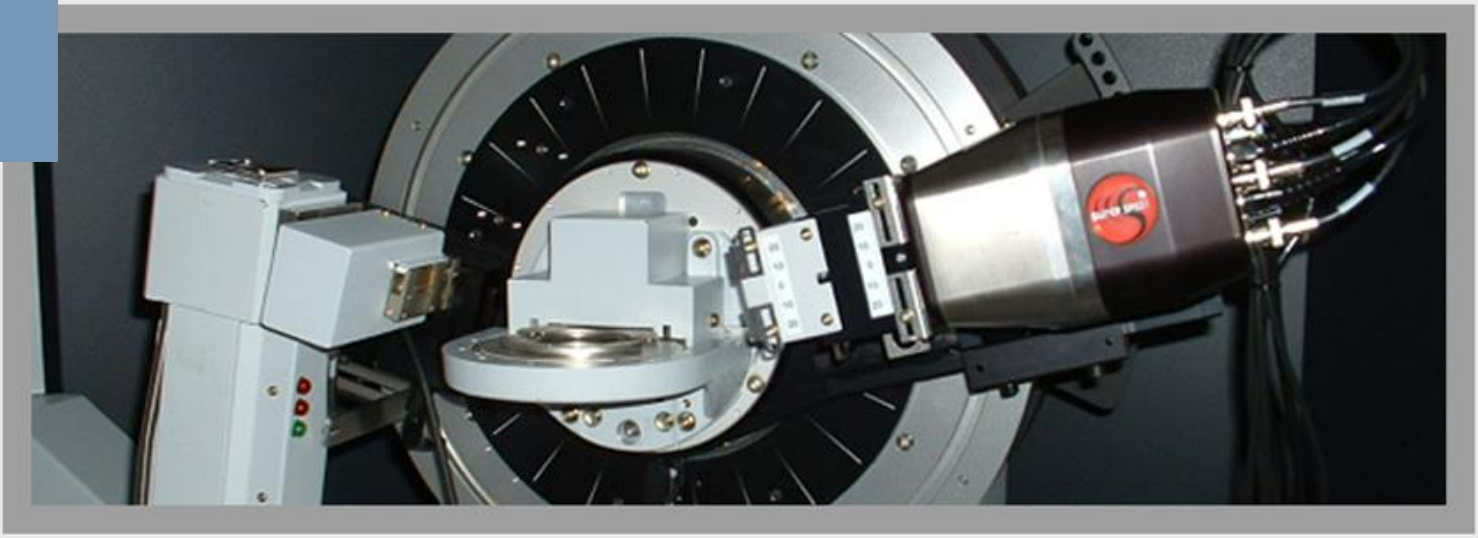
Head of the training unit

Patricia Patrier, patricia.patrier@univ-poitiers.fr

Course unit: **Minerals/Materials characterization techniques – Part 2**

Semester 2 - ECTS credits: 3 - 15h lecture, 7h tutorials, 3h practicals - Teaching language: English

First Year



Based on examples and applications to clays and other minerals, we will see how to use a wide range of techniques dedicated to solid characterization (spectroscopy, diffraction) to better analyze, understand and model mineral structures. The module will mainly rely on the study of the structures and crystal chemistry of lamellar materials and more specifically clays. The great chemical and structural diversity of these minerals makes them complex subjects of study, thus allowing us to understand the analysis capabilities and limitations of the different instruments with a complex natural material.

Objectives

This module, in two parts, is intended for all students who, in their professional life, will be confronted with scientific instrumentation and/or the characterization of natural/synthetic material using physical methods.

The second part of this module is intended to allow a thorough interpretation of spectroscopic and diffractometric signals. Detailed and quantitative information on the properties and structures of minerals/materials is thus possible.

Content

1) Diffraction:

After being introduced to the basics of diffraction in the first part of the module, students will learn about the advanced possibilities of X-ray diffraction. This part of the module will thus address the physical and analytical details of diffraction through modelling approaches. In this way, structural and quantitative information can be extracted from minerals/materials.

-Application of X-ray diffraction to the identification of clay minerals (phyllosilicates)

-Specificities of lamellar materials and clay minerals with respect to X-ray diffraction (isomorphic substitutions, order-disorder, structural defects, stacking faults, interstratification)

-Quantitative mineralogical analysis of natural samples containing disordered phases (Rietveld modelling)

-Structural defects taken into account during structural characterization of lamellar materials (modelling of experimental diffractograms).

2) Additional mineral informations:

In order to obtain a panel of techniques for solid analyses, the course unit also covers the basics of the complementary techniques

- Introduction to transmission electron microscopy which allows to combine high image resolution with Fourier space information directly related to diffraction

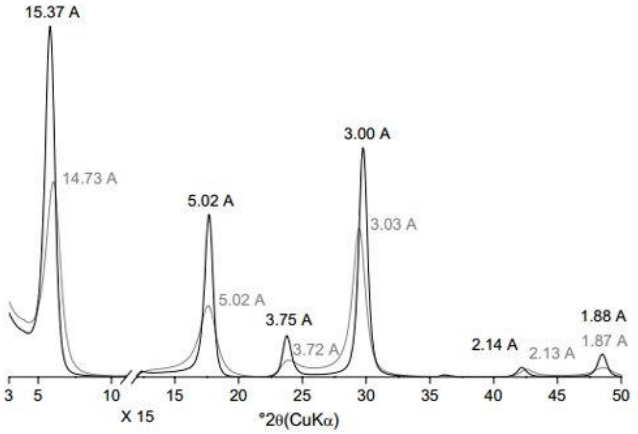
-Seminars will be held to discuss other techniques of solid state analysis (EPR...)

Prerequisites

- Bases of mineralogy
- Basics in mathematics, chemistry and physics (general science course)

Knowledge/skills acquired

- Solid knowledge of the crystalline structures and crystal-chemistry of lamellar mineral materials.
- Complete vision of the analysis of a mineral through different techniques (diffraction, spectroscopy).
- Ability to manage the entire chain of analysis, from sample preparation and data acquisition to final analysis and understanding radiation/material interactions.
- Ability to process a signal (XRD, FTIR...).
- Ability to extract the relevant crystal-chemical information while being aware of the limitations of their analyses.



Assessment

Final exam

Continuous assessment

Head of the training unit

Baptiste Dazas : baptiste.dazas@univ-poitiers.fr

Bruno Lanson : bruno.lanson@univ-grenoble-alpes.fr

Main contributors

Bruno Lanson, CNRS, ISTerre institute, Grenoble

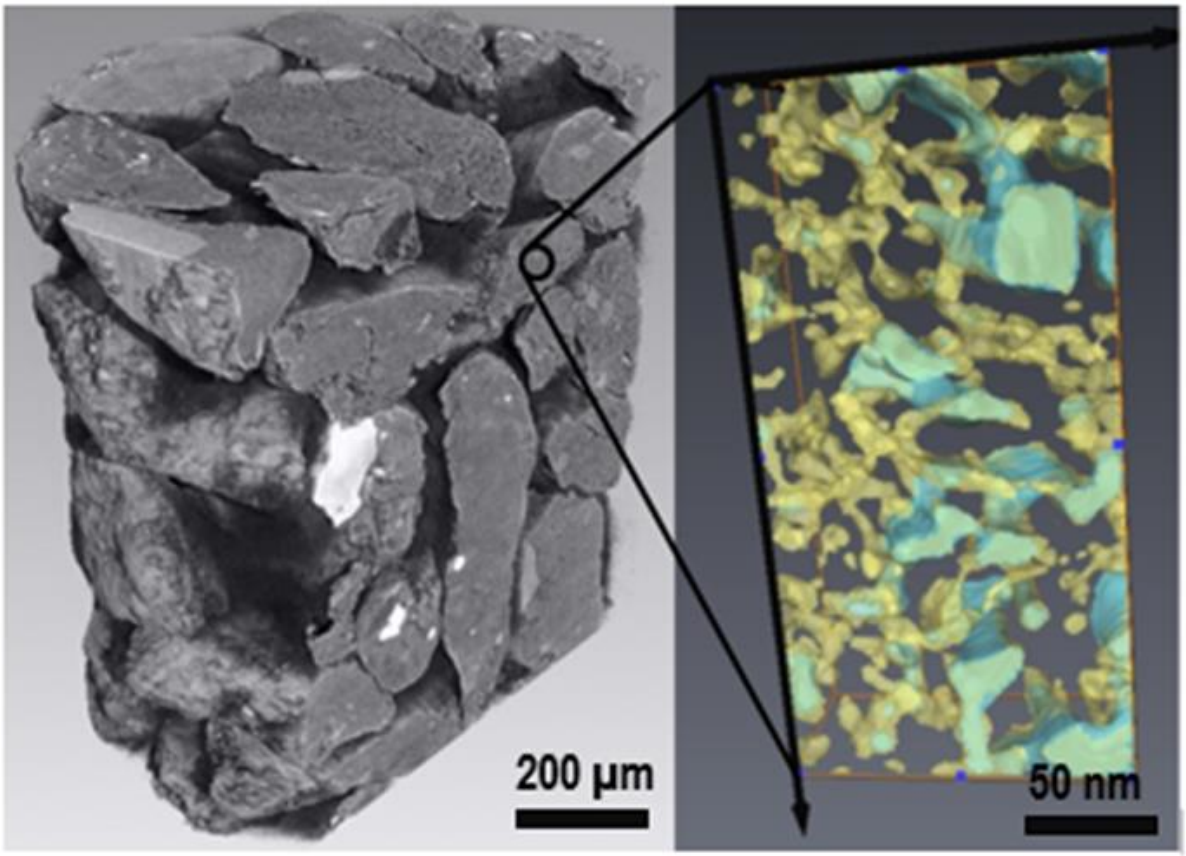
Eric Ferrage, CNRS, IC2MP institute, Poitiers

Marie Laure David, Poitiers University (PPRIME Institute)

Course unit: **Microstructure and imaging of materials**

Semester 2 - ECTS credits: 3 - 14h lecture, 2h tutorials, 9 practical) - Teaching language: English

First Year



The analysis of the rock microstructure (organization of minerals and pores) is pivotal for understanding their geological history and physical properties (fluid transfer and mechanical behavior). To solve this, imaging techniques are subject to intense developments and widely applied both for academic researches and industrials applications. The obtained data feed realistic modelling approaches of macroscopic physical properties of rocks.

Objectives

The aim is to understand the physics, the advantages and limitations of the different methods available for characterizing the microstructure in order to be able to combine them in a multiscale approach and feed realistic modelling of rock properties.

Content

•Advanced gas adsorption methods for pore network and reactive surface analyses.

•Preparation methods for microscopy

•2D/3D imaging techniques of the solid skeleton and pore network at different scales : quantitative mapping of minerals and porosity from core scale down to the crystal scale

•Practices: acquisition and advanced treatment of gas adsorption isotherms and imaging data (chemical mapping, X-ray tomography, 2D and 3D high resolution scanning electron microscopy, autoradiograph).

Prerequisites

•Unit formula calculations, beam/matter interactions, excel, clay crystal-chemistry.

Knowledge/skills acquired

•Being able to analyse the organization of materials by using cutting-edge imaging technics at different scales and accounting for their limitations and advantages.

•Being able to analyze the pore network by classical bulk methods, taking account of the assumptions applied.

Assessment

Practical activity report

Head of the training unit

Prêt Dimitri, dimitri.pret@univ-poitiers.fr

Main contributors

Prêt Dimitri, Poitiers University (IC2MP Institute)

Isabelle Gener Batonneau, Poitiers University (IC2MP Institute)

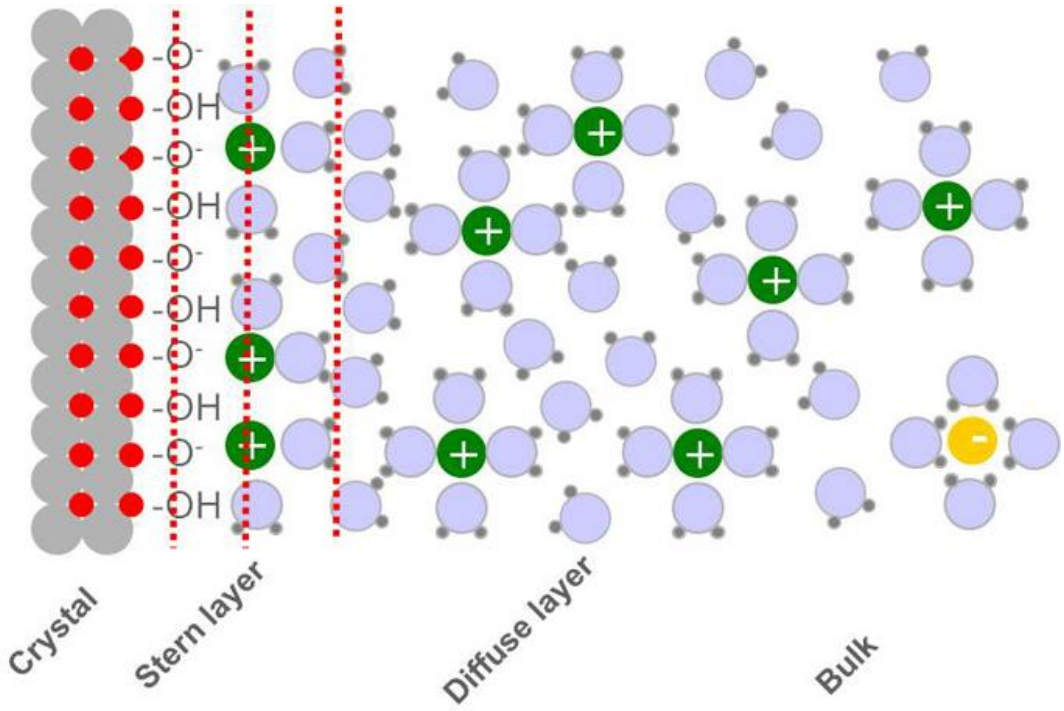
Fabien Thomas, CNRS, LIEC Nancy

Sophie Billon, Poitiers University (IC2MP Institute)

Course unit: **Solid/solution interface**

Semester 2 - ECTS credits: 3 - 10h lectures, 7h tutorials, 8h practicals - Teaching language: English

First Year



This unit is devoted to give the basis of chemical and physical properties of fine minerals and organic particles diluted in water. We will focus more on adsorption of solute on mineral colloid especially by taking into account their surface charge, and on their coagulation/flocculation properties.

Objectives

One of the objectives is to know the main experimental techniques used to obtain the surface site density and associated charge of colloids (fine particles). Another objective is to be able to know how to obtain an adsorption isotherm of a solute on a colloid particle and to interpret it. Finally, an important objective is also be able to predict the colloidal stability (or flocculation) of a system composed of fine particles diluted in water.

Content

- Colloid definition
- Functional groups and associated charge of colloids – Specific case of clay minerals
- Electrical double layer – associated model ; electrophoretic mobility
- Examples of thermodynamic models describing solute adsorption onto mineral surfaces
- Coagulation/flocculation and colloidal stability
- Implication of colloidal stability in engineering

Prerequisites

- Mineral definition – Knowledge of the structure of the main phyllosilicates
- Knowledge of the main ions located in natural waters
- Knowledge of the definitions of specific surface area and material porosity

Assessment

Continuous assessment

Head of the training unit:

Emmanuel Tertre (emmanuel.tertre@univ-poitiers.fr)

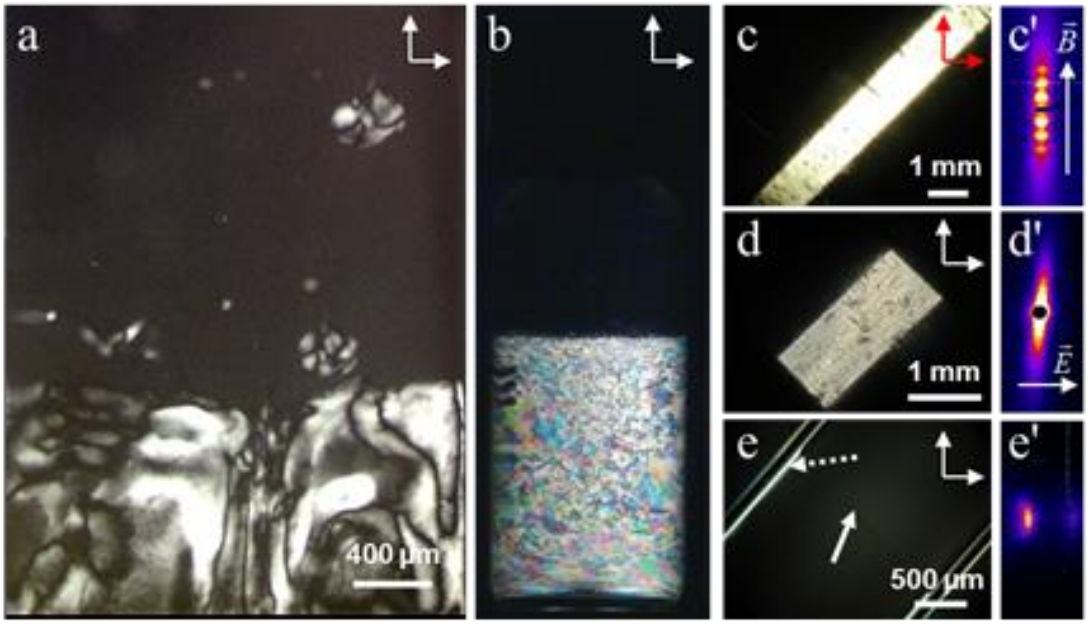
Main contributors

Emmanuel Tertre, Poitiers University (IC2MP Institute)
Fabien Thomas, CNRS, Université de Lorraine, LIEC

Course unit: **Organization of clay suspensions**

Semester 2 - ECTS credits: 3 - 9h lectures, 7h tutorials, 9h practicals - Teaching language: English

First Year



This unit will present the different possible structures of colloidal systems (in water saturated conditions) and will try to make the link with rheological properties. Concepts concerning electrostatic interactions (type, condition and range), auto-organization and phase transitions will be introduced in general and illustrated in the cases of clayey dispersions. The structural and mechanical behavior will be analyzed by using tools as small-angle X-ray scattering and rheology in saturated conditions. The analysis of data will familiarize students with experimental approaches, especially on the type of information which can be obtained.

Objectives

The main objective of this unit will be to give basics of physico-chemistry and tools in order to determine/predict the structure of colloidal dispersions in relation with the physico-chemical parameters of the media (salinity, solid/solution ratio...) and intrinsic properties of the fine particles chosen (size, morphology, surface charge...). The different concepts will be illustrated by giving examples issued from everyday life and scientific literature.

Content

- Colloidal stability (DLVO theory, repulsive and attractive forces)
- Structural organization of repulsive colloidal systems in water saturated conditions (using data from small-angle X-ray scattering)
- Liquid crystal - phase transition
- Relation between structure of colloidal system and rheological properties

Prerequisites

Knowledge of:

- Electrical double layer
- Mechanical properties and rheological models

Knowledge/skills acquired

- Predict the colloidal behavior of a colloidal dispersion (stability versus aggregation)
- Comment a phase diagram salinity/solid-solution ratio for a colloidal system
- Know the structural parameters of a colloidal system which can be obtained from the analysis of small-angle X-ray scattering data.
- Make the link between mechanical properties obtained at the macroscopic scale and colloidal organization obtained at the meso and microscopic scales.

Assessment

Final exam

Continuous assessment

Head of the training unit

Erwan Paineau, erwan-nicolas.paineau@u-psud.fr

Main contributors

Erwan Paineau, Paris Sud University (LPS Lab.)

Emmanuel Tertre, Poitiers University (IC2MP Institute)

EUR InTREE Common course units 2

Semester 2 - ECTS credits: 3 - 32h lectures - Teaching language: English

First Year

INTREE
Graduate School of Research

Interfaces for aeronautic energy and environment

These course units are IntREE specific cross-disciplinary course units. Therefore, they are attended by all registered EUR IntREE student (including all IMACS students).

Objectives

The EUR "interfaces" related courses available all along the student's academic progress provide students with a sound practical, methodological and theoretical grounding in interfaces problems, in relation to the scientific project objectives.
The objective of common courses is to introduce advanced interfaces-related courses and favoring transdisciplinary in addition to core curriculum vitae.

Content

1) Electrical phenomena at interfaces: Electrohydrodynamic phenomena are complex physical mechanisms due to the interaction between electrical charges and flowing fluids (gas or liquids). Their study requires knowledge of physics and fluid mechanics. In practice, these phenomena result in the motion of a fluid by the application of an electric field, or inversely by the generation of an electric current due to a fluid flow. In this course, the phenomena of charge creation at the solid-fluid interfaces as well as the exchanges of electrical charges at these same interfaces will be explained and studied.

2) Surface topography and its effect on interactions with fluids and solids: Solid surfaces, structure and topography, interaction of a liquid with a solid surface, interaction of two solid surfaces (surface roughness, surface topography, wetting, friction, adhesion, contact mechanics, fluid solution interface, solid-solid interface).

3) Surface and interface design for heterogeneous catalysis:

- Catalysis principles
- Surface/interfaces properties
- Design of catalysts (stucture-performances relationships)
- Application of heterogeneous catalysts in the field of environment and energy will be emphasized during seminars.

4) Introduction to spectroscopies

Prerequisites

•BSc of Sciences

Assessment

Continuous assessment (written exams in class room)

Contributors

Eric Moreau, Poitiers University (PPRIME Institute) (1)
Noël Brunetière, Poitiers University (PPRIME Institute) (2)
Laurence Pirault Roy, Poitiers University (IC2MP Institute) (3)
Brian Gregoire, Poitiers University (IC2MP Institute) (3)
Claudia Gomez, Poitiers University (IC2MP Institute) (3)

First year internship

Semester 2 - ECTS credits: 12

First Year

3 months internship in university or industrial laboratories. This internship is a key element of the training because it allows a complete immersion in a professional environment (academic laboratory and/or company). For EUR students, this internship must be carried out outside Poitiers Geoscience laboratory "HydrASA" to encourage mobility.

Objectives

The objective of this module is to develop:

- Organizational skills (working independently, conducting information research, implementing and carrying out a project)
- Relational skills (integration into a professional environment)
- General scientific skills (implementation of a scientific approach)
- Specific disciplinary skills

The student will have to be able to use information and communication technologies, to prepare adapted communication materials, to speak in public, to present the major scientific points of his or her work.

Examples of internships:

Environment - soil

- Environmental impact of the Torkuduk mine (Kazakhstan) - Uranium recovered by in-situ recovery (AREVA)
- Environmental impact of a former Cu, Sn mine (AREVA)
- Characterization of transported and/or precipitated solids in mine effluents (AREVA)
- Importance of clay minerals for trapping metallic elements in the lagoon of New Caledonia (Program CNRT-ADIIP / Univ. Aix Marseille)
- Development of mesoporous organo-siliceous compounds for trapping organic pollutants in aqueous phase (Univ. Aveiro)
- Use of HDL in decontamination (Charles Gerhardt Institute, Montpellier)
- Effects of environmental parameters on phosphate adsorption by kaolinite (Eco&Sols, Montpellier - INRA)
- Mineralogical evolution induced by plant activity and K consumption (ISTerre, Grenoble)...

Exploration/Exploitation mining and energy

- Petrography and sedimentology of the Francevillian Basin - Gabon (Univ. Poitiers)
- Hydrocarbon migration in Los Chihuidos Formation, Neuquen Basin, Argentina. (Univ. Poitiers - Univ. Comahue)
- Hydrothermal alteration associated with the epithermal deposit at Ag de Navidad (Argentina) - (IC2MP Univ. Poitiers - Univ. Rio Negro Argentina)
- Use of portable IR spectrometry for high energy geothermal exploration (Guadeloupe) (BRGM)
- Spectral analysis of iron oxides and associated clay minerals and their application to iron deposits (CSIRO - Australia)
- Characterization of clay minerals identified in the Gold Mine of Mont Ity gold (Ivory Coast), prospecting assistance (LA MANCHA)
- Crystallochemistry and typology of chlorite coverings in sandstone reservoirs: impact of the sedimentary environment and early transformations (TOTAL)

Civil Engineering

- Limits of use of clay sands in bituminous binders: physico-chemical study (IFSTTAR)
- Handling of dust during excavation and construction phases, impact on water consumption (IFSTTAR)
- Spatial distribution of drying slots in marsh soils: tomography coupling - electrical resistivity (IC2MP, Univ. Poitiers)
- Development of a method for a field diagnosis on the swelling behaviour of clays (BRGM)
- Mineralogical control of the petrophysical properties of clayey rocks: Study of the Montiers-Sur-Saulx site (ANDRA)
- Co-valorisation of materials applied to dredged sediments (IFSTTAR)

Geomaterials, nanomaterials

- Effect of clays on cement hydration (IFSTTAR-IMN-LAFARGE)
- Characterization of kaolinite properties in the Rio Capim region (North Brazil). (UFRGS)
- The rheological and organophylic properties of a Uruguayan bentonite. (Tech. Univ. of Crete)
- Extraction of aluminum by acid treatment of kaolin. (Tech. Univ. of Crete)
- Processes for improving low quality kaolin. (Tech. Univ. of Crete)
- Impact of alumino-silicate source on geopolymer formation - (IFSTTAR)
- Textured ceramics based on phyllosilicates: formulation, processes, properties (ENSCI Limoges)
- Study of Manganese speciation in an industrial process involving Montmorillonite clays (IPSEN)
- Bacterial Reduction of Synthetic Nontronites (Univ. Ottawa)

Geoarcheology

- Physico-chemical characterization of plaster coatings and wall flakes for buildings of the Iron Age in western Gaul (Saint-Georges-les-Baillargeaux; Paule; Quimper; Prat, site of Pouilladou...) (IC2MP-HeRMA lab., Univ. Poitiers)
- Analysis of the degradation of green marble: Raman mapping of the serpentine structure (CICRP - CINaM Marseille)
- Determination of the origin of the rocks constituting the historical monuments of Poitiers. (EMR Poitiers)

Kazakhstan

Course unit: **Industrial clays – Geomaterials**

Semester 3 - ECTS credits: 3 - 12,5h lecture, 12,5h tutorials, seminars - Teaching language: English

Second Year

Industrial minerals and geomaterials (kaolin, quartz, talc, feldspar, clay, lime...) are natural raw materials essential for the manufacture of products of everyday life (buildings, vehicles, computers, medicines, paper, paint, plastic, glass, cosmetics, etc.). They therefore represent major economic issues, and a need to know the structure and physico-chemical properties of these materials, thus conditioning their use and their economic interest.

Objectives

The objective of the course unit is to provide the students with fundamental on industrial clays and on uses and reactivity of clay based material (including reuses and recycling).

Content

(i) The principal aspects of industrial clays. The students receive a brief introduction in clay mineral structures followed by presentation of the main physical properties of clays valued by the industry (cation exchange capacity, plasticity, viscosity, colour, particle size distribution, reactions with organic and inorganic molecules). The main types of industrial clays are presented (bentonites, kaolins, palygorskite and sepiolite, vermiculite, common clays and shales). For each type of industrial clay the geological, mineralogical and geochemical characteristics are presented followed by techniques for their characterization and by assessment routes. Typical examples will be presented. The students perform an evaluation of characteristic industrial clays in the laboratory (bentonite, kaolin) and prepare their own reports. Finally each student presents a seminar on a specific topic related to industrial clays

(ii) The uses and reactivity of these clay or clay-based geomaterials for various applications related to building materials and civil engineering. The students will discover various routes such as cements/concretes, geopolymers, composite materials, and soil stabilization. The rheology of geomaterials will also be seen because of its importance in knowledge phenomena and their use. The students perform practical materials-making applications that they will characterize from beginning to end.
Finally, in accordance with the circular economy the reuse and recycling of geomaterials will be introduced. The module also provides a realistic idea of the research and development sector in this area.

Prerequisites

Bases of mineralogy and characterization of clays.

Knowledge/skills acquired

- To become familiar with the industrial clays and their properties
- To be able to characterize and evaluate industrial clay deposits for the most important industrial applications
- To become familiar with geomaterials and the reactivity of clays during mixed reactions

Assessment

Final exam

Continuous assessment

Head of the training unit

Emmanuel Joussein, emmanuel.joussein@unilim.fr

Main contributors

- Emmanuel Joussein, University of Limoges (PEREINE- GRESE)
- George Christidis, Technical University of Crete, School of Mineral Resources Engineering
- Dimitri Deneele, CNRS, IMN Nantes
- Gisèle Lecomte, Limoges University (SPCTS)

Course unit: **Clays in cultural heritage**

Semester 3 - ECTS credits: 3 - 10h lecture, 10h tutorials, 5h practical - Teaching language: English

Second Year

Shibam town in Yémen – Portal La Martyre church in Britany – Sumerian divine list AO 5376 face, Louvre museum

The course unit “clays in cultural heritage” proposes to present an overview of conservation issues on built heritage as well as cultural heritage in museum dealing with clay mineral.
Clay minerals are present in sedimentary or metamorphic stones but also in an extremely wide and varied raw earth heritage. Color is also one of the most important properties of objects, in archaeology and art history. Among the traditional inorganic pigments, iron oxides and earth are considered for their archaeological evidence and their uses (medicinal, religious, decorative purposes...).

Objectives

. How is identified this heritage, and what are its conditions of conservation? To answer these questions, we propose to contextualize clay minerals within the porous material, and show how clay minerals can be a source of strength and a weakness for objects and buildings.

Content

This course is the opportunity to show:

- Impacts of hydric and hygric deformations that can cause heavy damages on buildings (flaking, cracking of withdrawal, etc...).
- A multiscale approach of material from capillary cohesion between clays and grains to build buildings for millennia.
- The know-how of clays and ceramics: origin of the raw material, evolution of ceramic techniques through the ages: multi-scaled analytical protocols illustrated with examples from the most famous ceramic productions.
- Unfired clays artifacts and their conservation challenge: Mesopotamian clay tablets, a complex researches involving interdisciplinary teams.
- Applied research on causes of degradation in buildings, and the ways to conserve and restore this extremely rich heritage: a conservation approach different from the museum conservation.
- Clays and their specific properties used for conservation purposes of object and building (cleaning, desalination...).
- Pigments: Chemical composition, structural and chromatic properties, stability and also both natural origin and synthetic production from the modern times will be presented.

Knowledge/skills acquired

- Ability to understand a multiscale approach
- Ability to understand issue between conservation and innovating researches

Assessment

Final exam

Continuous assessment

Head of the training unit

Ann Bourges, ann.bourges@culture.gouv.fr

Main contributors

Anne Bouquillon, C2RMF, Le Louvre Paris

Anne Solenn Leho, C2RMF, Le Louvre Paris

Ann Bourgès, Laboratoire de recherche des monuments historiques, Champs-sur-Marne

Course unit: **Functionalized layered materials/minerals and bio-interfaces**

Semester 3 - ECTS credits: 6 – 26h lecture, 10h tutorials, 14h practicals - Teaching language: English

Second Year

This course unit is divided in 2 parts:

1) Functionalized lamellar materials: In order to meet environmental and societal challenges, the use of abundant and inexpensive natural or synthetic minerals and materials is particularly important. The modification/functionalization of lamellar materials/minerals and the understanding of the structure-property relations allow to increase their fields of application, which can thus be aimed at catalysis, health, environmental remediation, energy storage or conversion and the development of mineral fillers as polymer additives (nanocomposites). .

Objectives

The objective of this part is to provide the student with the necessary basis of modified clays, layered double hydroxides and nanocomposites and skills in the synthesis and modification of these materials as well as in characterization (structural/property relationships, advanced characterization methods).

2) Bio-interfaces : The use of geological nanomaterials to heal skin or other infections has been evident since the earliest recorded history, and specific clay minerals may prove valuable in the treatment of bacterial diseases, including infections for which there are no effective antibiotics. Overuse of antibiotics in healthcare is a major concern because of the consequential proliferation of antimicrobial resistance. Recent research studies highlight the effective inactivation of antibiotic resistant microorganisms using appropriate clays, as an alternative approach towards public health protection and elimination of infectious diseases

Objectives

The objectives of the course unit is to introduce environmental microbiology and the behavior/response of microorganisms to biocidal factors. This introduction includes i) the composition of microbial cell and the main groups of microorganisms involved with public health issues, and which may be found in the environment; ii) antimicrobial properties of clays in relation to the different mechanisms of resistance which may be induced in microbial cells ; iii) evolution of microorganisms in terms of the development of resistance under environmental stressed conditions and its overall impact for public health.

Content

Part 1. Functionalized lamellar materials/minerals

Modified clays

- Modifications of clays by ion exchange and grafting
- Modifications of clays by direct synthesis
- Thermal behavior

Modified LDH and LDH

- Direct synthesis and morphology of LDH
- Hybrid LDH and LDH structures and microstructures
- Green Rust: Formation, structure, reactivity and environmental impact

Nanocomposites Clay and functional materials

- Nanocomposites: Polymer-clay and clay-nanoparticles
- New developments in research

LDH Nanocomposites and Functional LDH Materials

- Properties, functionalization and application of LDH
- Practical work: Synthesis of LDH in soft chemistry

Content

Part 2. Bio-interfaces

•Introduction to environmental microbiology – major microbial groups important for public health
•Microbial nutrition/growth
•Antibiotic resistant bacteria – microorganisms and metal pollutants
•Clays VS microorganisms – microbial terminology (bacteriostatic & bactericidal agents)
•Healing clays
•Testing antibacterial properties of clays
•Antibacterial components present in therapeutic muds – mode of action
•Antibacterial activities of clay minerals against antibiotic-susceptible and antibiotic-resistant bacterial pathogens
•Clay polymer nanocomposites (CPNs) for the removal of microorganisms
•Advanced oxidation processes for environmental applications

Prerequisites

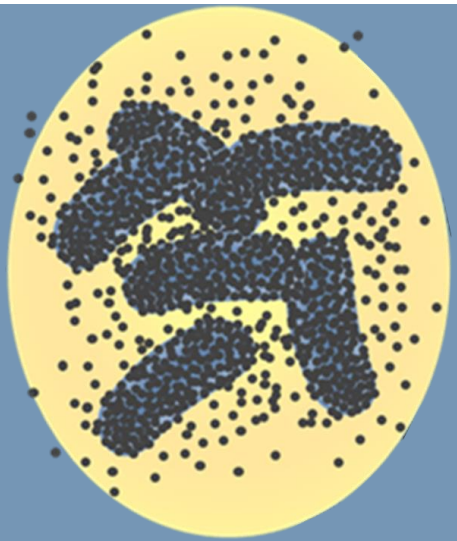
•Basic knowledge in clay mineralogy and characterization techniques

Knowledge/skills acquired

•Perform/know the methods of synthesis and modification of lamellar and mineral materials.
•Predict or implement an approach to predict the structure/property relationships of materials and minerals.
•Implement advanced characterization methods.
•Bases on the beneficial effects of clays in terms of their use as antimicrobial agents against virulent pathogens considered threats to public health. Familiarization with the applications of environmental microbiology and methods used for the evaluation of microbial resistance in the presence of biocidal factors.

Assessment

Final exam, literature review, continuous assessment



Head of the training unit

Brian Gregoire, brian.gregoire@univ-poitiers.fr
Danae Venieri, danae.venieri@enveng.tuc.gr

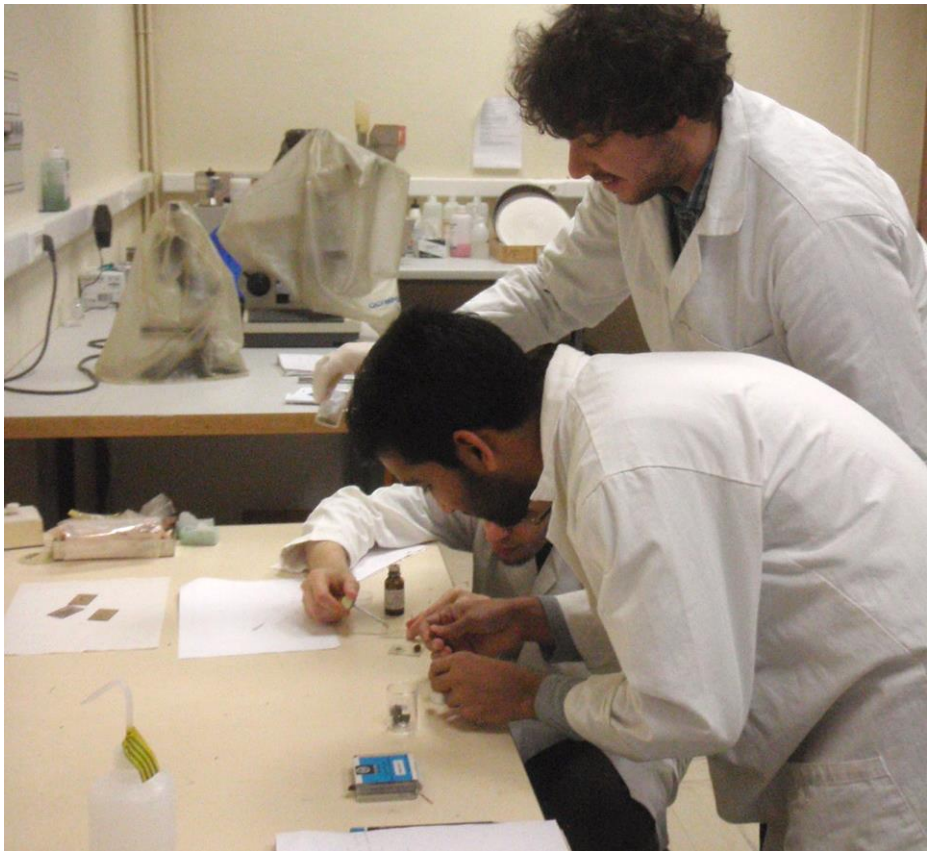
Main contributors

Brian Grégoire, Poitiers University (IC2MP Institute); Claude Forano, Christine Taviot Gueho, Vanessa Prevot (Institute of Chemistry of Clermont Ferrand); Jocelyne Brendlé, Haute Alsace University (IS2M Institute); Danae Venieri, Iosifina Gounaki (Technical University of Crete - Environmental Microbiology Lab.)

Course unit: **Environmental Civil Engineering: geotechnical hazards and sustainable applications of clay geomaterials**

Semester 3 - ECTS credits: 3 – 12h lectures, 2h tutorials, 11h practical - Teaching language: English

Second Year



This module is an introduction to civil engineering and geotechnical activities related to the presence of clayey geomaterials (soils, rocks, backfill materials). It is devoted to the description of the macroscopic (mechanical and rheological) and microscopic behavior of clays in soils or rocks.

Objectives

This module aims to make students aware of the potential of clays and the problems they generate. Indeed, although clays are remarkable materials because of their properties (e.g. rheological properties that make them good drilling muds, low permeability that allows them to ensure the tightness of structures), they are nevertheless at the origin of many problems in civil engineering. Their detection in a ground intended to receive a pavement or a building requires the implementation of specific measures (e.g. adapting the dimensioning of the structure, reinforcing the foundations or the structure, treating the ground). In contrast, clay swelling properties (responsible for disorders underneath buildings in times of drought) are used to ensure the sealing of the structure to waste storage.

Content

Introduction to the mechanics of clay geomaterials

The course covers the main characterizations of the mechanical behavior of clay geomaterials:

- Physical characterization (densities, void index, porosity, granulometry ...)
- (Hydro) mechanical characterization: Terzaghi principle, Biot parameters.
- Consolidation of clay soils: role of interstitial water, oedometric test.

The influence of mineralogy and clay structure on the mechanical response is also introduced.

At the end of the course, students, in groups of two or three, conduct a geotechnical project. This project deals with the computation of the settlements of a petroleum tank carried out on a compressible clay soil.

Shrinkage and swelling of soils under foundation

The course presents a global approach of shrinkage-swelling phenomenon (geotechnical hazard) or how to take into account the presence of swelling clays in soil under a construction. The microscopic properties of clays are revised (classification, microstructure, ability to swell...) and how it can help geotechnicians to characterize the in situ soil sensitivity to shrinkage and swelling. Climatic factors and geological, hydrological and topographic context related to the site have to be considered too. The map and risk prevention plans have to be consulted and on-site recognition and laboratory tests applied. Finally, the factors that can trigger or aggravate the swelling-shrinkage phenomena as well as the different ways to prevent damages by acting on construction or on soil are presented.

Clay soil treatment and durability: earthwork and surface waste storage

The course covers the various aspects of techniques related to clay materials implementation in the field. This module aims at raising students' awareness on: the different phases of earthworks projects and at emphasizing the importance of the choice of materials; the opportunity to take benefit of the physical and chemical properties of clays for engineered barriers; the various techniques of soil treatments to reinforce the durability of the performance of waste materials.

At the end of the course, the students, in groups of two or three, carry out a project around issues related to earthworks and in particular on the soil-atmosphere interaction.

Tunnel and underground structures in clayey rocks

The behavior of underground structures in clay rocks has been studied for many years, particularly in the context of radioactive waste disposal projects. This course takes stock of the knowledge acquired in the field and presents the problems related to digging tunnels and underground structures in clay rock masses. Particular emphasis is placed on sizing, excavation and support methods in clayey rocks. The course is illustrated by real cases to highlight the specificities of these materials, including the development of the damaged zone, and the adaptations they require in different methods of digging and support.

Introduction to (natural or synthetic) clays, cement, plaster and ceramic pastes rheology

This course is an introduction to geomaterials rheometry and their application in the field of civil engineering with a practical session on materials. The first part presents the theoretical bases of rheology by presenting the behavior laws used with geomaterials, with some results illustrating the theory. Then a presentation of the measurement tools used both in situ and in laboratory is made with particular emphasis on the different geometries of laboratory rheometers. The assumptions related to their use are detailed from a theoretical and practical point of view as well as the advantages and disadvantages inherent to each geometry. At the end of the course, a project is proposed to the students in the form of measurements (Practical session) and analysis (in autonomy) of results on clay suspensions. They analyze their experimental curves with free software that they can download legally and by using scientific reference articles distributed for this purpose.

Prerequisites

Education in Earth sciences, Physics (material), Physical chemistry.

Knowledge/skills acquired

- Basics of soil and rock mechanics, rheology of pastes and suspensions.
- Geotechnical description of a soil or rock (geotechnical identification).
- Microstructural description of a clayey soil (mineralogy and microstructure)
- Introduction to the problems generated by clays in civil engineering
- Basics of soil treatment in earthworks

Assessment

Final exam

Continuous assessment

Head of the training unit

Myriam Duc, myriam.duc@ifsttar.fr

Philippe Cosenza, philippe.cosenza@univ-poitiers.fr

Main contributors

Myriam Duc, IFSTTAR / GERS/ SRO, French Institute for Transport, Development and Networks Science and Technology

Philippe Cosenza, Poitiers University (IC2MP Institute)

Sébastien Jarny, Poitiers University (PPRIME Institute)

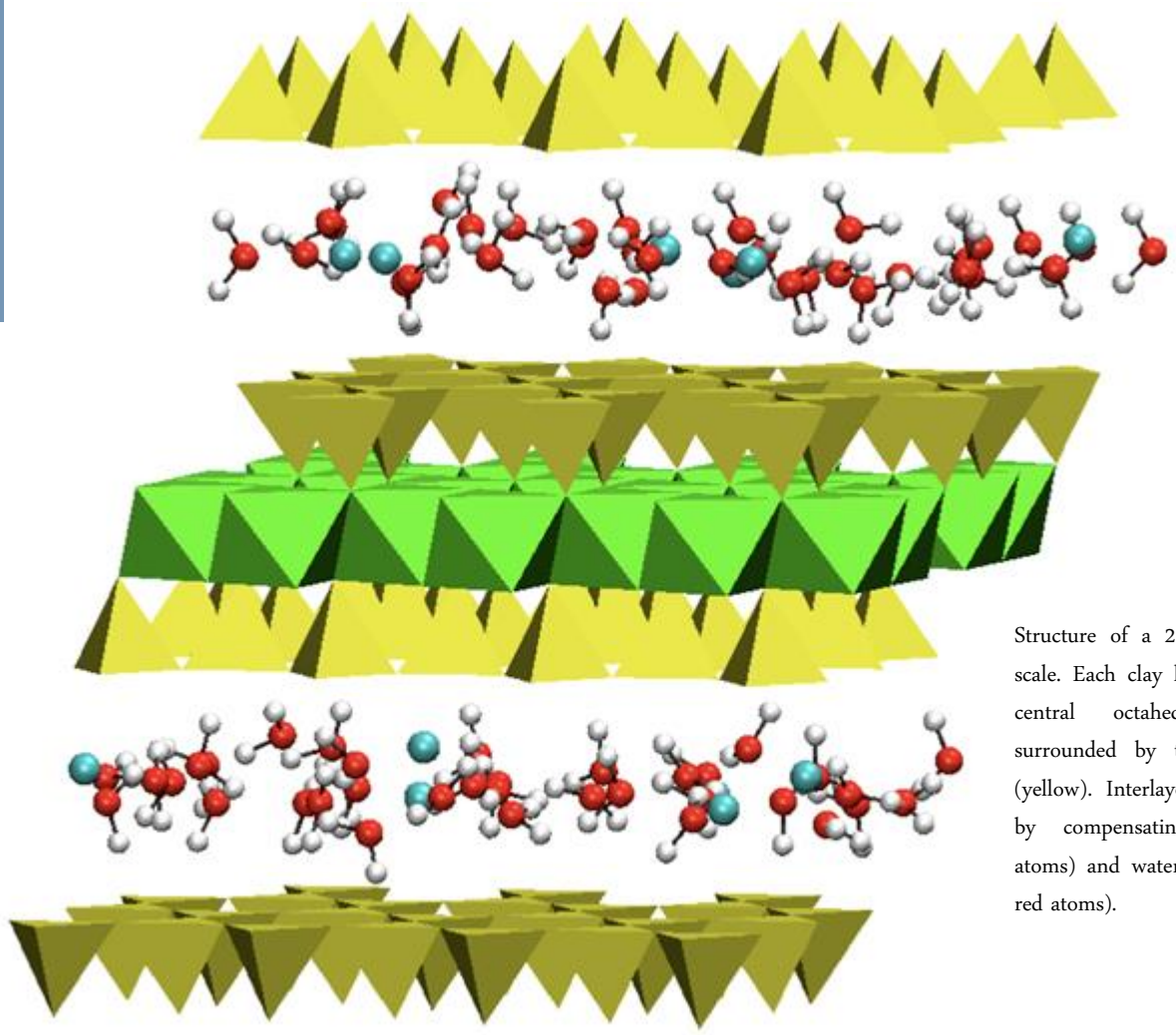
Richard Giot, Poitiers University (IC2MP Institute)

Andry Razakamanantsoa, IFSTTAR/GERS/GMG (French Institute for Transport, Development and Networks Science and Technology)

Course unit: **Molecular Modeling**

Semester 3 - ECTS credits: 3 - 5h lectures, 20h practical - Teaching language: English

Second Year



Structure of a 2:1 clay on the atomic scale. Each clay layer is composed of a central octahedral sheet (green) surrounded by two tetrahedral sheets (yellow). Interlayer spacing is occupied by compensating counterions (blue atoms) and water molecules (white and red atoms).

Modelling (numerical simulation) is an approach used increasingly in all scientific branches, including material science, chemistry, biology and physics. Its ascent, since the 1980s, goes hand in hand with the ever-increasing computational power, as well as improvements in the simulation algorithms used. Within a given model of a system, modelling allows measuring physical quantities that are inaccessible experimentally, either because of low signal intensities or due to extreme conditions, such as high temperatures and pressures. Modelling can now be considered as part of the standard set of tools to study mineral materials.

Objectives

The objectives of this course unit is to introduce the principal methods used to simulate structure and dynamics in minerals (Monte Carlo, Molecular Dynamics). This introduction is supported by numerous examples on clay materials (about half of the module is practical work) where the student encounters basics of programming, the general structure of a simulation code, and is shown how to exploit simulation results to arrive at meaningful physical quantities.

Content

After a reminder of the main concepts of statistical thermodynamics necessary to understand atomic-level simulations (thermodynamic ensembles, ensemble averages etc.), the two main methods of atomic-scale modelling are introduced: Monte Carlo and Molecular Dynamics. We show several recent examples of simulations on clays, highlighting the physical quantities they allow us to calculate. We finish by showing the multiple points of comparison of simulated data with experimental results, mainly by scattering techniques (X-ray and neutron scattering), and highlight the additional information simulations bring into the description of clays.

Prerequisites

Mathematical operations - including basics of integration and differentiation, basics of probability, basics of thermodynamics (1st and 2nd law, state functions), basics of atomic structures and crystallography.

Knowledge/skills acquired

- Main concepts of statistical thermodynamics and the principles of the two main methods of molecular modelling – Monte Carlo and Molecular Dynamics
- Basics of programming and general structure of a simulation code
- Simulation results exploitation to arrive at meaningful physical quantities.

Assessment

Final exam

Continuous assessment

Head of the training unit

Natalie Malikova, natalie.malikova@upmc.fr

Main contributors

Benjamin Rotenberg, CNRS, PHENIX lab. Paris

Virginie Marry, UPMC University Paris (PHENIX lab.)

Natalie Malikova, CNRS, PHENIX lab. Paris

Roland Pellenq, Massachusetts Institute of Technology (MIT)

EUR InTREE Common course units 3

Semester 3 - ECTS credits: 3 - 32h lectures - Teaching language: English

Second Year

INTREE
Graduate School of Research

Interfaces for aeronautic energy and environment

These course units are IntREE specific cross-disciplinary course units. Therefore, they are attended by all registered EUR IntREE student (including all IMACS students).

Objectives

The EUR "interfaces" related courses available all along the student's academic progress provide students with a sound practical, methodological and theoretical grounding in interfaces problems, in relation to the scientific project objectives.

Interdisciplinary knowledge is essential in promoting analysis, creativity, communication and critical thinking.

The objective of common courses is to introduce advanced interfaces-related courses and favoring transdisciplinary in addition to core curriculum vitae.

Content

1) **Molecular modeling**
2) **Introduction to rheology**

After an introduction to rheological behaviors, their links with physico-chemical properties are described. The flow in different geomaterials is concerned such as geomaterials (clay suspensions, concrete, cement paste), polymer melts, solutions or micelles.

The main behaviors laws are presented from a mathematical point of view. Then measurement geometries and typical protocols are described with their advantages and drawbacks. Finally application curves with different materials are analyzed using the introduced models

3) Characterization of porous networks

Methods for the characterization of porous networks (size, pore morphology, classification, connectivity) and reactive surfaces: pycnometry, gas adsorption isotherms and mercury porosimetry.

Physical phenomena controlling the distribution of fluids on surfaces in different types of pores.

Treatment of water and gas adsorption isotherms and mercury porosimetry results.

4) Digital and programming tools (part 2)

Prerequisites

- BSc of Sciences

Assessment

Continuous assessment (written exams in class room)

Contributors

Vincent Mauchamp, Poitiers University (PPRIME Institute) (1)
Sébastien Jarny, Poitiers University (PPRIME Institute) (2)
Dimitri Prêt, Poitiers University (IC2MP Institute) (3)
Julien Godet, Poitiers University (PPRIME Institute) (4)

EUR Practicum

Semester 3 - ECTS credits: 6 - 10h tutorials - Teaching language: English

Second Year

Group project in which 3 students enrolled in 3 different master courses have to carry out a joint project under the supervision of a researcher. The project shall be presented in a video format.

Assessment

Defense

Head of the training unit (for IMACS students)

Patricia Patrier, patricia.patrier@univ-poitiers.fr

Master thesis internship

Semester 4 – ECTS credits: 30 – 5/6 months

Second Year

Minimum 5 months internship (up to 6 months) in university or industrial laboratories. This internship is a key element of the training because it allows a complete immersion in a professional environment (academic laboratory and/or company).

Student will have to apply all the knowledge/skills acquired during the first 3 semesters to deal with a real scientific or technical problem.

Objectives

The objective of this module is to develop:

- Organizational skills (working independently, conducting information research, implementing and carrying out a project)
- Relational skills (integration into a professional environment)
- General scientific skills (implementation a scientific approach)
- Specific disciplinary skills

The student will have to be able to use information and communication technologies, to prepare adapted communication materials, to speak in public, to present the major scientific points of his or her work, to lead a scientific debate on the topic addressed during the internship and to propose extensions to his/her work.

Examples of internships:

Environment - soil

- Environmental impact of the Torkuduk mine (Kazakhstan) - Uranium recovered by in-situ recovery (AREVA)
- Environmental impact of a former Cu, Sn mine (AREVA)
- Characterization of transported and/or precipitated solids in mine effluents (AREVA)
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- Mineralogical evolution induced by plant activity and K consumption (ISTerre, Grenoble)...

Exploration/Exploitation mining and energy

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- Hydrocarbon migration in Los Chihuidos Formation, Neuquen Basin, Argentina. (Univ. Poitiers - Univ. Comahue)
- Hydrothermal alteration associated with the epithermal deposit at Ag de Navidad (Argentina) - (IC2MP Univ. Poitiers - Univ. Rio Negro Argentina)
- Use of portable IR spectrometry for high energy geothermal exploration (Guadeloupe) (BRGM)
- Spectral analysis of iron oxides and associated clay minerals and their application to iron deposits (CSIRO - Australia)
- Characterization of clay minerals identified in the Gold Mine of Mont Ity gold (Ivory Coast), prospecting assistance (LA MANCHA)
- Crystallochemistry and typology of chlorite coverings in sandstone reservoirs: impact of the sedimentary environment and early transformations (TOTAL)

Civil Engineering

- Limits of use of clay sands in bituminous binders: physico-chemical study (IFSTTAR)
- Handling of dust during excavation and construction phases, impact on water consumption (IFSTTAR)
- Spatial distribution of drying slots in marsh soils: tomography coupling - electrical resistivity (IC2MP, Univ. Poitiers)
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- Co-valorisation of materials applied to dredged sediments (IFSTTAR)

Geomaterials, nanomaterials

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- Textured ceramics based on phyllosilicates: formulation, processes, properties (ENSCI Limoges)
- Study of Manganese speciation in an industrial process involving Montmorillonite clays (IPSEN)
- Bacterial Reduction of Synthetic Nontronites (Univ. Ottawa)

Geoarcheology

- Physico-chemical characterization of plaster coatings and wall flakes for buildings of the Iron Age in western Gaul (Saint-Georges-les-Baillargeaux; Paule; Quimper; Prat, site of Pouilladou...) (IC2MP-HeRMA lab., Univ. Poitiers)
- Analysis of the degradation of green marble: Raman mapping of the serpentine structure (CICRP - CINaM Marseille)
- Determination of the origin of the rocks constituting the historical monuments of Poitiers. (EMR Poitiers)

Graduation ceremony