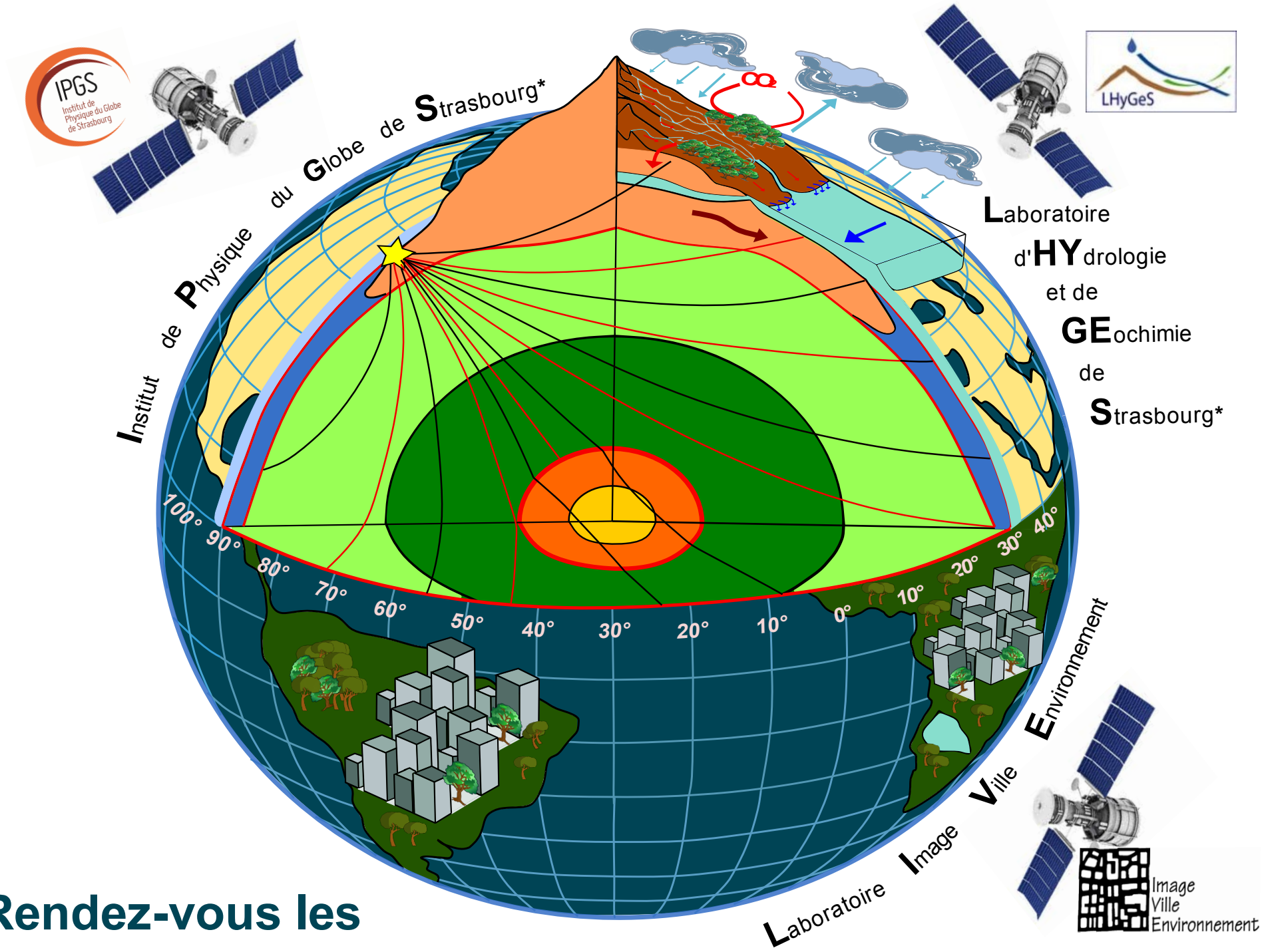
École et observatoire des **sciences de la Terre** de l'Université de Strasbourg et du CNRS

Institut **Terre & Environnement** de **Strasbourg** | ITES | UMR 7063 de l'**Université** de Strasbourg & **CNRS** & **ENGEES**

Congrès des doctorants

ED 413 : Sciences de la Terre et de l'Environnement



Rendez-vous les

Mardis 2 et 9 février 2021

Retrouvez tous les informations (programmes, horaires, infos pratiques, etc...) sur
http://eost.u-strasbg.fr/stue/

KEYNOTE

Par Christelle ROY:

Vice-présidente "Stratégie et développement"

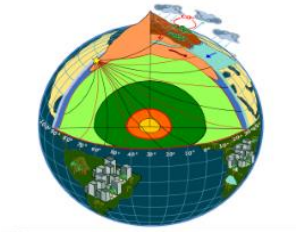
Sujet :

Projet de territoire de Fessenheim un engagement de la communauté scientifique dans une transition énergétique et environnementale réussie au sein de l'Europe.

*ITES (UMR 7063)

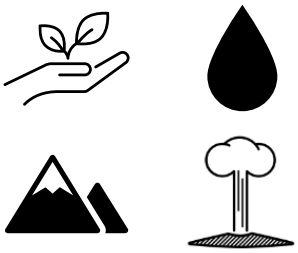
Congress of PhD students 2020-2021

The congress in 5 points



A talk session the 2nd of February 2021 and a poster session the 9th of February 2021 with a total of **38 presentations**!

The perfect occasion to meet new people, share sciences and win the best oral AND poster price!



4 topics:

- Fifty shades of deformation processes
- Geothermal reservoirs and fluid-rock interactions
- Near-surface hydrology: from the lab to the global scale
- Anthropogenic impact on the environment: make landscape, air and water quality great again!

A **KeyNote** from Christelle Roy : “Projet de territoire de Fessenheim : un engagement de la communauté scientifique dans une transition énergétique et environnementale réussie au sein de l’Europe”

For any question do not hesitate to contact us at congresdesdoctorantsed413@gmail.com. You also will find a lot of information on the congress **website.**

Oral presentation day (The 2nd of February)

Due to the COVID pandemic, the oral presentation day will take place fully remotely on Big Blue Button. Please find below the connection link:

Link to the Congress room

The oral day is divided in 4 sessions (2 in the morning, 2 in the afternoon), each session being dedicated to one the following topics:

- Fifty shades of deformation processes
- Geothermal reservoirs and fluid-rock interactions
- Near-surface hydrology: from the lab to the global scale
- Anthropogenic impact on the environment: make landscape, air and water quality great again!

For more information, please see the detailed program in the next pages.

Opening of the day (the 2nd of February, from 08:00 to 08:15)

Rendez-vous to the main congress room for the welcoming speech, and for drinking a coffee together!

KeyNote from Christelle Roy (the 2nd of February, from 08:15 to 08:45)

We are very honored to receive Ms. Christelle Roy, vice president of Strategy and development at the University of Strasbourg. Ms. Roy will give a talk about the involvement of the scientific community toward a successful environmental and energy transition in Europa. She will focus on the case of the dismantling of the Fessenheim nuclear power plant. For more details, please visit the page of the project.

08:15 to 08:45	Christelle Roy (vice president of the chair “Strategy & development” at Strasbourg University)
Projet de territoire de Fessenheim : un engagement de la communauté scientifique dans une transition énergétique et environnementale réussie au sein de l’Europe.	

Geothermal reservoirs and fluid-rock interactions (the 2nd of February, from 09:00 to 10:35)

Injection well at the Theistareykir geothermal power plant (Iceland)

9:00 to 09:15	Jean-Baptiste MATHIEU (LhyGes/ITES)
Computation and use of pressure loss and enthalpy variation table in well layout optimization context	

9:20 to 9:35	Julien PORTE (IPGS/ITES)
Complex resistivity inversion using Controlled Source Electromagnetic method	

9:40 to 9:55	Carole GLAAS (IPGS/ITES)
Clay mineralogy: a signature of granitic geothermal reservoirs of central Upper Rhine Graben	

10:00 to 10:15	Flora HOCHSCHEID (IPGS/ITES)
Geochemical study of serpentinization along an ocean-continent transition zone: The Alpine Tethys as a case study (SE-Switzerland)	

10:20 to 10:35	dariush JAVANI (IPGS/ITES)
Hydro-Mechanical Modeling of the Year 2000 Hydraulic Stimulation of GPK2 Well, Soultz-sous-Forêts, France	

Fifty shades of deformation processes: from Earthquakes to plate tectonics (the 2nd of February, from 10:40 to 12:35)

Deep seated gravitational slope deformation in the alpine mountains

10:40 to 10:55	Luc MOUTOTE (IPGS/ITES)
Low significance of foreshock activity in Southern California	

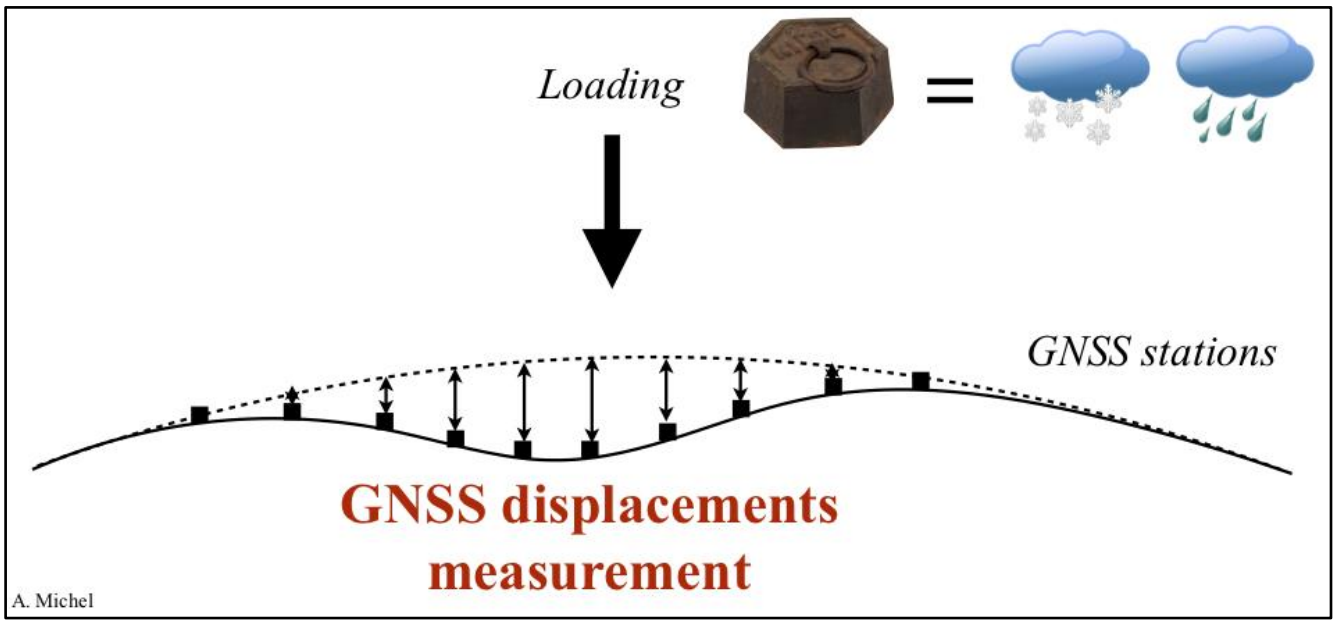
11:00 to 11:15	Emmanuel CABALLEROLEYVA (IPGS/ITES)
Insight on rupture dynamics from probabilistic fault models of the 2014 Iquique	

11:20 to 11:35	Lucille CARBILLET (IPGS/ITES)
Cooking synthetic rocks in the laboratory: preparing “sandstones” with known microstructural attributes	

11:40 to 11:55	Peng CHAO (IPGS/ITES)
The tectono-stratigraphic and magmatic evolution of conjugate rifted margins: insights from the NW South China Sea	

12:00 to 12:15	Thifhelimbilu faith MULABISANA (IPGS/ITES)
Active Tectonics, Crustal Deformation and Seismotectonic background for a realistic Seismic Hazard Assessment in southern Africa	

Near-surface hydrology: from the lab to the global scale (the 2nd of February, from 13:30 to 15:30)



Displacement of the ground in response to hydrological loading

13:30 to 13:45	Minghe ZHANG (IPGS/ITES)
Modeling and Inversion of GPR Signals for Estimating Hydraulic Properties of Unsaturated Sandy Soils	

13:50 to 14:05	Hugo LECOMTE (IPGS/ITES)
Study of the accuracy of GRACE products	

14:10 to 14:25	Alexandre MICHEL (IPGS/ITES)
Surface seasonal deformations in western Europe computed from a massive GNSS processing of a global network with the GINS/PC software	

14:30 to 14:45	Quentin CHAFFAUT (IPGS/ITES)
Time-lapse gravimetry as a tool to calibrate a physically based distributed hydrological model	

14:50 to 15:05	Daniel Steven MORENOMARTIN (LHyGeS/ITES)
Hydrodynamic and thermodynamic simulation in the Strengbach catchment	

15:10 to 15:25	Mouna Chaguer (LHyGeS/ITES)
Development of the integrated hydrological model NIHM: Implementation of transport processes	

Anthropogenic impact on the environment: make landscape, air and water quality great again! (the 2nd of February, from 15:30 to 17:00)

The old Rhine, nearby Fessenheim

15:30 to 15:45	Marcoandres GUEVERALUNA (LIVE)
Analysis of energy transition in the Trinational Metropolitan Region Oberrhein region	

15:50 to 16:05	Mariadelourdes PRIETOESPINOZA (LHyGeS/ITES)
Reactive transport of dichloromethane and micropollutants in laboratory aquifers: an integrative approach	

16:10 to 16:25	Benjamin KELLER (LIVE)
Geohistory and geoarchaeology of agrarian landscapes in Grand Est : Shapes, plots and territories	

16:30 to 16:45	Caline LY KENG (LIVE)
Industrial releases and its impact on the Upper Rhine river: geo-history and legal approaches	

16:50 to 17:05	Angela OSORIO (LIVE)
Management and ecological restoration of the protected areas of the “Bande rhénane”: construction of a participatory and adaptive methodology	

Poster day (the 9th of February, morning only)

Poster presentations will take place remotely on the BigBlueButton platform in the morning of the 9th of February. It consists in two consecutive sessions merging all the thematic.

Please find below the connection link to the main congress room:

Link to the Congress room

CONGRÈS DES DOCTORANTS 2021

For helping attendees to prepare question about the work of their colleague, poster together with a small presenting soundtrack will be made available two days in advance on the congress **website**.

Each presenter will have his own virtual room on the BigBlueButton platform, the link is already available (please see the detailed program in the next pages). You will need to be ready for any questions from visitors and be present throughout the session (About 1h30). If you have any question you will find somebody in the main congress room.

Opening of the day (the 9th of February, from 8:45 to 9:00)

Rendez-vous to the main congress room for the welcoming speech, and for drinking a coffee together!

Session 1 (the 9th of February, from 9:00 to 10:30)

9:00 to 10:30	Sara TABRIZINEJADAS (LHyGeS/ITES)
Improvements in Reactive Transport Models for electro diffusion process in porous media based on Nernst-Planck-Poisson Equation	
BBB link	

9:00 to 10:30	Monica AQUINOGUERRA (IPGS/ITES)
Joint Inversion of Passive Geophysical Data	
BBB link	

9:00 to 10:30	Qinglin DENG (IPGS/ITES)
Anisotropy of hydraulic diffusivity due to fracture surface roughness and fracture closure	
BBB link	

9:00 to 10:30	Virginie HAMANN (LIVE)
The role of the living environment in the social inequalities in the physical activities of pregnant women residing in the eurometrople of Strasbourg – (ENVIFEM)	
BBB link	

9:00 to 10:30	John VILLAR (LIVE)
Desirable Cities	
BBB link	

9:00 to 10:30	Cassandra EUZEN (LIVE)
Anthropogenic trajectory in the Upper Rhine through the dynamics and the composition of the sedimentary deposits	
BBB link	

9:00 to 10:30	Samirasadat SOLTANI (LHyGeS/ITES)
Estimation of groundwater storage using assimilating GRACE TWSA into hydrological model	
BBB link	

9:00 to 10:30	Bashayer AL-SHAMMARI (LHyGeS/ITES)
Modeling of seawater intrusion in coastal aquifer at Kuwait city	
BBB link	

Session 2 (the 9th of February, from 10:45 to 12:15)

10:45 to 12:15	Valentin SIMONCIC (LIVE)
Adverse Birth Outcomes Related to NO2 and PM Exposure	
BBB link	

10:45 to 12:15	Quentin POTEREK (LIVE)
Unprecedented and ancient spatial data for assessing the effect of past changes on current floristic biodiversity	
BBB link	

10:45 to 12:15	Romain WENGER (LIVE)
U-Net for multi-class classification using imbalanced dataset: Application on urban areas in Grand Est	
BBB link	

10:45 to 12:15	Kamel DRIF (IPGS/ITES)
Source parameters of the Ml3.0 Strasbourg Earthquake	
BBB link	

10:45 to 12:15	Tobias JUNGINGER (LHyGeS/ITES)
Leaching and transformation of the urban triazine biocide terbutryn: insights from Compound-Specific Isotope Analysis	
BBB link	

10:45 to 12:15	Nicolas MERCURY (IPGS/ITES)
The 2018-2020 seismo-volcanic crisis, east of Mayotte, Comoros islands: in-depth study of poorly instrumented first months of the sequence	
BBB link	

10:45 to 12:15	Franck LATALLERIE (IPGS/ITES)
Resolution and Uncertainties of Tomographic Models for Quantitative Analysis: A Surface Wave Example From the Pacific	
BBB link	

10:45 to 12:15	Rohianuu MOUA (IPGS/ITES)
Parametrization of hydrogeological models using geophysical methods	
BBB link	

10:45 to 12:15	Clément BOIVIN (IPGS/ITES)
Long and short-time evolution of deep-seated gravitational slope deformation: contribution to knowledge of phenomena for the management of alea in the alpine mountains	
BBB link	

Award announcement (the 9th of February, from 12:20 to 12:40)

Framadate

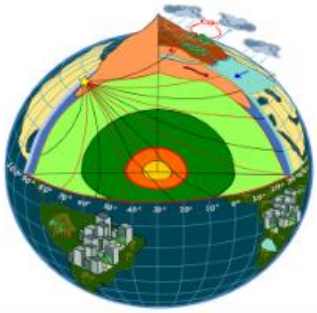
Vote for the best poster of the congress!

best poster election

Framadate

Vote for the best talk of the congress!

best talk election



CONGRÈS DES DOCTORANTS 2021

Contents

I. Oral presentation 02/02/2021 3

Theme 1 : Geothermal reservoirs and fluid-rock interactions 3

Jean-Baptiste MATHIEU: Computation and use of pressure loss and enthalpy variation table in well layout optimization context 3

Julien PORTE: Complex resistivity inversion using Controlled Source Electromagnetic method 4

Carole GLAAS: Clay mineralogy: a signature of granitic geothermal reservoirs of central Upper Rhine Graben. 5

Flora HOCHSCHEID: Geochemical study of serpentinization along an ocean-continent transition zone: the Alpine Tethys as a case study (SE-Switzerland) 6

Dariush JAVANI: Hydro-Mechanical Modeling of the Year 2000 Hydraulic Stimulation of GPK2 Well, Soultz-sous Forêts, France 7

Theme 2. Fifty shades of deformation processes: from Earthquakes to plate tectonics. 8

Luc MOUTOTE: Low significance of foreshock activity in Southern California 8

Emmanuel CABALLEROLEYVA: Insight on rupture dynamics from probabilistic fault models of the 2014 Iquique earthquake 9

Lucile CARBILLET: Cooking synthetic rocks in the laboratory: preparing “sandstones” with known microstructural attributes 10

Peng CHAO: The tectono-stratigraphic and magmatic evolution of conjugate rifted margins: insights from the NW South China Sea 11

Thifhelimbilu faith MULABISANA: Active Tectonics, Crustal Deformation and Seismotectonic background for a realistic Seismic Hazard Assessment in southern Africa 12

Theme 3 : Near-surface hydrology: from the lab to the global scale. 13

Minghe ZHANG: Modeling and Inversion of GPR Signals for Estimating Hydraulic Properties of Unsaturated Sandy Soils 13

Hugo LECOMTE: Study of the accuracy of GRACE products : Magnetic, gravimetric and geodetic constraints on the dynamics of the fluid core 14

Alexandre MICHEL: Surface seasonal deformations in western Europe computed from a massive GNSS processing of a global network with the GINS/PC software 15

Quentin CHAFFAUT: Time-lapse gravimetry as a tool to calibrate a physically based distributed hydrological model 16

Daniel Steven MORENO MARTIN: Hydrodynamic and thermodynamic simulation in the Strengbach catchment 17

Mouna Chaguer: Development of the integrated hydrological model NIHM: Implementation of transport processes 18

Theme 4 : Anthropogenic impact on the environment: make landscape, air and water quality great again ! 19

Marcoandres GUEVARALUNA: Analysis of energy transition in the Trinational Metropolitan Region Oberrhein (TMO) region 19

Mariadelourdes PRIETOESPINOZA: Reactive transport of dichloromethane and micropollutants in laboratory aquifers: an integrative approach 20

Benjamin KELLER: Geohistory and geoarchaeology of agrarian landscapes in Grand Est : Shapes, plots and territories 21

Caline LY KENG: Industrial releases and its impact on the Upper Rhine river: geo-history and legal approaches 22

Angela OSORIO: Management and ecological restoration of the protected areas of the "Bande rhénane": construction of a participatory and adaptive methodology 23

Corentin BERGER: Modeling of physico-chemical processes impacting the concentration of particles in indoor air: assessment with experiments in simulated atmosphere chambers 24

II. Poster presentations 09/02/2021 25

Session 1 : 25

Sara TABRIZINEJADAS : Improvements in Reactive Transport Models for electro diffusion process in porous media based on Nernst-Planck-Poisson Equation 25

Monica AQUINOGUERRA : Joint Inversion of Passive Geophysical Data: Magnetotelluric and Ambient Seismic Noise 26

Qinglin DENG: Anisotropy of hydraulic diffusivity due to fracture surface roughness and fracture closure 27

Virginie HAMMAN: The role of the environment in the social inequalities in the physical activities of pregnant women residing in the eurometropole of Strabourg – (ENVIFEM) 28

John VILLAR: Desirable Cities 29

Cassandra EUZEN: Anthropogenic trajectory in the Upper Rhine through the dynamics and the composition of the sedimentary deposits 30

Samirasadat SOLTANI: Estimation of groundwater storage using assimilating GRACE TWSA into hydrological model 31

Bashayer AL-SHAMMARI: Modeling of seawater intrusion in coastal aquifer at Kuwait City 32

Session 2 : 33

Valentin SIMONCIC: Adverse Birth Outcomes Related to NO2 and PM Exposure 33

Quentin POTEREK: Unprecedented and ancient spatial data for assessing the effect of past changes on current floristic biodiversity 34

Romain WENGER: U-Net for multi-class classification using imbalanced dataset: Application on urban areas in Grand Est Region 35

Kamel DRIF: Source parameters of the Ml3.0 Strasbourg Earthquake (12th November 2019) 36

Tobias Junginger: Leaching and transformation of the urban triazine biocide terbutryn: insights from Compound-Specific Isotope Analysis 37

Nicolas MERCURY: The 2018-2020 seismo-volcanic crisis, east of Mayotte, Comoros islands: in-depth study of poorly instrumented first months of the sequence. 38

Franck LATALLERIE: Resolution and Uncertainties Of Tomographic Models for Quantitative Analysis : A Surface Wave Example From the Pacific. 39

Rohianuu MOUA: Parametezization of hydrogeological models using geophysical methods 40

Clément BOIVIN: Long and short time evolution of deep seated gravitational slope deformation : contribution to knowledge of phenomena for the management of alea in the Alpine mountains 41

I. Oral presentation 02/02/2021

Theme 1 : Geothermal reservoirs and fluid-rock interactions.

Computation and use of pressure loss and enthalpy variation table in well layout optimization context

Jean-Baptiste Mathieu[1,2], Michel H. Garcia[2], Philippe Ackerer[1]

[1] LHyGeS, Université de Strasbourg/EOST/ENGEES – CNRS, 1 rue Blessig, F-67084 Strasbourg, France
[2] KIDOVA, 155, av. Roger Salengro – 92 370 Chaville, France

jean-baptiste.mathieu@etu.unistra.fr

The optimization of well layouts (OWL), or more generally of petroleum, geothermal or hydrogeological reservoir development plans, requires to state an optimization problem, i.e., an objective (gain, cost or loss) function and decision parameters (freedom degrees) that must be selected at best to maximize or minimize the objective function. Looking at optimal well layouts for geothermal reservoirs, the objective is to maximize pressure and temperature at the production well locations, in certain way that the geothermal energy resource extraction is maximized. Therefore, most of literature objective functions are based on the production and injection rates and the produced fluids state variables (pressure, enthalpy) (Lee, 2001, Moon and Zarrouk, 2012, Lu et al., 2018).

Most of reservoir flow and heat transport simulators such as TOUGH2, ECLIPSE or HYDROTHERM, account for development plans through imposed production or injection rate concentrated in a gridblock per well (i.e.: local Neumann boundary conditions). For any single well, the reservoir simulator outputs (P_{gb}, T_{gb}), the pressure and temperature at the center of the reservoir gridblock where the well produce a rate Q_{gb}. Knowing P_{gb}, T_{gb} and Q_{gb}, one must be able to deduce (P_{wh}, T_{wh}) the pressure and temperature at the well head to check that they satisfy the input conditions required by the geothermal power plant and evaluate the reservoir development plan overall performances.
The two steps required to compute (P_{wh}, T_{wh}) from (P_{gb}, T_{gb}) are the following.

1. Computation of P_{wb}, the well bottom pressure, from P_{gb} at temperatures expected constant ($T_{wb} = T_{gb}$): The pressure loss $DeltaP_{b2b} = P_{gb} - P_{wb}$ being computed using the well productivity index (PI) and the production rate in the gridblock Q_{gb}.
2. Computation of (P_{wh} , T_{wh}), the well head pressure and temperature from (P_{wb}, T_{wb}): The pressure loss $DeltaP_w = P_{wb} - P_{wh}$ and the temperature loss $DeltaT_w = T_{wb} - T_{wh}$ are evaluated by well flow and heat transport simulation, based on the well bottom boundary conditions (P_{wb}, T_{wb} and Q_{gb}) and the well length. The temperature variations are due to the fluid cooling from its vaporization (when it occurs inside the well) and the possible heat exchanges with surrounding rock formations by diffusion. The pressure losses are due to the fluid column (liquid and vapor) weight and the flow frictions.

Strictly speaking, the second step requires to be simulated for each well (well paths being variables) and the well flow simulation should be repeated each time (P_{gb}, T_{gb} or Q_{gb}) change. This approach is not conceivable if the reservoir flow simulation is not coupled with the well flow simulation ($DeltaP_w$ computation) and using a specific well model ($DeltaP_{b2b}$ computation). In TOUGH2, the rate control by well head conditions is usually achieved by providing table of minimal well bottom hole pressures required to satisfy well head pressure conditions, for increasing production rates. Each time-step production rate Q_{gb} is then selected based on simulated fluid conditions (P_{gb}, T_{gb}) using user-defined productivity index.

As an alternative to this approach, that requires *a priori* pressure loss table and well-specific model definition, it is possible to simulate constant production rates and compute well head pressure and vapor fraction afterward, to verify that they satisfy the geothermal power plant requirements. This approach is more suitable to assess a large number of layout performances (millions of them), as required by the optimization process.

In that context, the wells features (radius, completion…) are shared, only the well lengths (h_w) are expected to be well-specific. Then, the well flow numerical simulation step can be done before (and outside) the optimization process, to properly fill a single calculation table that is able to instantly provide accurate ($P_w(Zm\text{-}h_w)$, $T_w(Zm\text{-}h_w)$) knowing ($P_w(Zm) = P_{wb}$, $T_w(Zm) = T_{wb}$) for the production rate Q_{gb} and any of the h_w used in the possible development plans. The oral presentation will provide the main aspects of this alternative approach and focus on the required calculation table requirements and uses in the well layout optimization process. Discussion about the accuracy of this approach will be illustrated against full numerical well flow simulation results.

Keywords: calculation table, TOUGH2, W1D, well flow numerical simulation, well layout optimization.

Complex resistivity inversion using Controlled Source Electromagnetic method

J. Porté[1,2], J-F. Girard[1], F. Bretaudeau[2]

[1]IPGS (UMR 7516 CNRS / University of Strasbourg)
[2] BRGM (French Geological Survey)

julien.porte@unistra.fr

Controlled Source Electromagnetic (CSEM) method is an imaging technique using a multi frequency electromagnetic signal [10^{-2} – 10^{4} Hz] to obtain the electrical conductivity of the un derground, up to 3 km depth. This medium property is usually considered as a real and constant value. Nevertheless, in some Earth materials, induced polarization (IP) phenomena are occurring when an electric perturbation is applied. These mechanisms are described by a frequency depen dent complex resistivity. Relaxation model parameters describing these phenomena allow to access to several properties of interest linked essentially to the pore space properties, fluid content or presence of disseminated metallic particle.

Complex resistivity is usually studied using electrical method with direct current (DC) hy pothesis, neglecting by the way electromagnetic e ect. Nevertheless, DC hypothesis shows strong limitation with increasing o set and frequencies when coupling with EM induction occurs. To fully recover IP information or to take into account IP perturbation in a CSEM data set, we implemented a frequency dependent complex resistivity in the 3D Finite-Di erence CSEM modelling and inver sion code, POLYEM3D (Bretaudeau et al). A multi-stage approach is de ned to undertake the multi-parameter problem, taking advantage of appropriate data information in each stage according to their sensitivity. Furthermore, to manage an increasing number of parameters, a second order polynomial support is used to describe frequency variation of complex resistivity.

We show through synthetic inversions that we are able to recover a 3D complex resistivity image and its frequency variation from CSEM data in the IP/EM coupling domain where IP signal is su ciently large compared to EM induction. Our inversion procedure allows then to access to IP parameters of the medium in an extended frequency domain as well as a better investigation depth.

Clay mineralogy: a signature of granitic geothermal reservoirs of central Upper Rhine Graben.

Carole GLAAS[1,2,3,*], Patricia PATRIER[2], Jeanne VIDAL[4], Daniel BEAUFORT[2], Albert GENTER[1]

[1]ES-Géothermie, 26 bld Président Wilson, 67000 Strasbourg, France
[2]University of Poitiers, UMR 7285 IC2MP, HydrASA, CNRS, Bat B8 Rue Albert Turpain, TSA51106, F-86073 Poitiers Cedex 9, France
[3]University of Strasbourg, UMR 7516 IPGS, CNRS, 5 Rue René Descartes, 67084 Strasbourg Cedex, France
[4]University of Chile, FCFM, Department of Geology, Andean Geothermal Center of Excellence (CEGA), Plaza Ercilla 803, Santiago, Chile

cglaas@unistra.fr

Clay minerals are frequently the signature of hydrothermal alteration related to fluid circulation in basement rocks. In the French part of the Upper Rhine Graben deep-seated granites, illitic minerals (illite and I/S mixed layers) are classical products of the argillic alteration resulting from the hydrothermal activity structurally controlled by the faults and fractures network in the Palaeozoic basement. In the new Illkirch geothermal well, drill-cuttings were studied with various petrographic methods to compare their alteration mineralogy with that of Soultz and Rittershoffen and to determine the characteristics of illite in paleo- and present-permeable zones. Alteration petrography, crystallography and chemical composition of illitic minerals and chemical composition of the altered bulk rocks, were performed all along the well. This complete characterization allowed to find that the illitic minerals composed of illite and illite-rich illite-smectite mixed layers (<10% smectite) that predominate at Illkirch are similar to those already characterized at Soultz and Rittershoffen. Fracture zones are characterized by the occurrence of the illitic material, and more precisely, present-permeable zones seem to be characterized by the presence of illite and I/S mixed layers whereas paleo-permeable zones seem only to be associated with illite. This indicates that illite formed likely under paleo temperatures higher (>200°C) than those measured today and that the I/S mixed layers were formed at the present temperatures (150-200°C) and hence are the markers of the present-day circulations.

Directeurs de these:
M GIRARD Jean-François Professor, University of Strasbourg
Mme PATRIER Patricia Professor, University of Poitiers

Encadrant industriel:
M GENTER Albert Deputy general manager, ÉS-Géothermie

Geochemical study of serpentinization along an ocean-continent transition zone: the Alpine Tethys as a case study (SE-Switzerland)

F. HOCHSCHEID[1,*], M. ULRICH[1], M. MUNOZ[2], D. LEMARCHAND[3] AND G. MANATSCHAL[1]

[1]Université de Strasbourg, UMR7516 Institut de Physique du Globe de Strasbourg, 1 rue Blessig, 67084 Strasbourg (**fhochscheid@unistra.fr**, mulrich@unistra.fr, gianreto.manatschal@unistra.fr)

[2]Université de Montpellier, UMR 5243 Géosciences Montpellier, Place Eugène Bataillon, 34095 Montpellier Cedex 05 (manuel.munoz@umontpellier.fr)

[3]Université de Strasbourg, UMR7517 Laboratoire d'Hydrologie et de Géochimie de Strasbourg, 1 rue Blessig, 67084 Strasbourg (lemarcha@unistra.fr)

The Platta, Tasna and Totalp nappes (SE-Switzerland) represent remnants of a former Ocean-Continent Transition (OCT) of the Alpine Tethys. These nappes are mainly composed of subcontinental peridotites that have been strongly serpentinized during their exhumation to the seafloor. Since these rocks have been preserved from Alpine metamorphism, they provide a unique opportunity for studying fluid-rock interactions and mass transfer related to the serpentinization processes affecting the subcontinental lithospheric mantle in OCTs. Here, we present a comprehensive study including petrological, mineralogical (XRD and μ-XRF) and geochemical (major and trace element concentrations, Sr-B isotopes) data on serpentinites with the aim of constraining the nature of serpentinizing fluids, the chemical transfers and the conditions (pH, temperature) at which serpentinization occurred.

Mineralogical observations show that primary silicate minerals (i.e., olivine and pyroxenes) are rarely preserved in serpentinites, and that several generations of serpentine are identified. Trace element concentrations of serpentinites display a strong enrichment in fluid mobile elements such as Li, B, Sb, Cs and U compared to initial peridotite. Radiogenic and stable isotope compositions suggest that serpentinization occurs under a wide range of temperatures (150-300°C) and at low fluid-rock ratios (< 20), similar to those observed in mid-ocean ridge serpentinites. Based on B and Sr isotopic signatures, we demonstrate that serpentines recorded the evolution of the serpentinizing fluid composition over the serpentinization course in exhuming subcontinental mantle.

Hydro-Mechanical Modeling of the Year 2000 Hydraulic Stimulation of GPK2 Well, Soultz-sous Forêts, France

Dariush Javani, Jean Schmittbuhl, Francois Cornet

ITES, University of Strasbourg/CNRS

dariush.javani@unistra.fr

Hydraulic stimulation of pre-existing fractures and faults plays a significant role in improving hydraulic conductivity of the fracture network around injection and production wells in geothermal reservoirs. It is therefore important to characterize the hydro-mechanical behavior of the faults against fluid injection. The Soultz-sous-Forêts site (France) has been an EGS pilot site where several major hydraulic stimulations have been performed and are well documented (https://cdgp.u-strasbg.fr/ and https://tcs.ah-epos.eu/).

Here we use the 3DEC numerical modeling tool (Itasca) to analyze the year 2000 stimulation of GPK2 well where large scale seismic anomalies have been evidenced during the different stages of the stimulation using 4D-P-wave tomography (Calo et al, 2011). The specificity of the approach is to combine two modeling at different scales. First, a small-scale model (100x100x100 m^3) is built to analyze the effective mechanical response of a stochastic discrete fracture network (DFN) following the statistical features of the observed fracture network (Massart et al, 2010). Second, a large-scale numerical model of the Soultz-sous Forêts reservoir (5000x5000x5000 m^3) containing the largest faults of the reservoir defined by Sausse et al., 2010, is developed including regional stresses. The objective is to constrain the large-scale mechanical properties of the surrounding matrix around the fault from the small-scale model, in particular, its hydro mechanical behavior in terms of non-linear elastic response related to the stochastic DFN. As a first step only the largest fault (GPK3-FZ4770) is considered (Figure 1B). The first stage of the stimulation (green rectangle at figure 1A) is modelled as a constant flow rate of 30 ls^{-1} of water injected into the fault at the depth of approximately 4.7 km. We explored the effect of the normal and shear stiffness of the fault on the dynamical response of pore pressure along the fracture and the onset of slip. It is found that the increase of the aperture of the fault during the injection shows a slow migration (~2 cm/s) owing to poro-elastic effects. Also generated fluid pressure throughout the fault shows a long period oscillating behavior (~5 hr) sensitive to the magnitude of the fracture normal stiffness. Interestingly, the fracture shear stiffness, fracture size, dip, and dip direction did not have significant impact on the observed dynamic behavior of the aperture/pressure propagation.

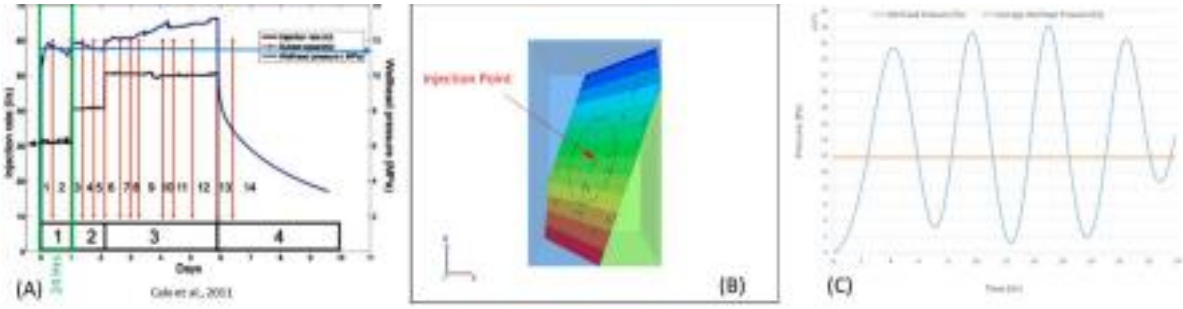


Figure (1): The year 2000 GPK2 stimulation Procedure (A); 3DEC model of the block and embedded fracture (B); Numerical wellhead pressure oscillation at injection point of approximately 4.5 km (C); the average value of the oscillated wellhead pressure (red line in (C)) of about 12 MPa has good agreement with field value of wellhead pressure (blue arrow in (A)) of about 12 MPa

Keywords: hydraulic stimulation, DFN, non-linear hydro-mechanical coupling, 3DEC, pressure evolution.

Theme 2. Fifty shades of deformation processes: from Earthquakes to plate tectonics.

Low significance of foreshock activity in Southern California

L. Moutote[1], D. Marsan[2], O. Lenglin´e[1], and Z. Duputel[1]

[1]*Institut de Physique du Globe de Strasbourg, UMR7516, Université de Strasbourg/EOST, CNRS, Strasbourg, France.*
[2]*Institut des Sciences de la Terre, UMR5275, Université Savoie Mont Blanc, CNRS, Le Bourget du Lac, France.*

lmoutote@unistra.fr

Earthquakes preceding large events are commonly referred as fore shocks. They are often considered as precursory signals reflecting the nu cleation process of the main rupture. Such foreshock sequences may also be explained by cascades of triggered events. Recent advances in earth quake detection is a motivation to reevaluate seismicity variations prior to mainshocks thank to the low magnitude seismic activity highlighted. Thank to a template matching detection technique, a recent publication provided a very low completeness magnitude catalog of Southern Califor nia (Quake Template Matching catalog). Based on this highly complete earthquake catalog, Trugman and Ross (2019) and van den Ende and Am puero (2020) suggested that mainshocks in southern California are often preceded by anomalously elevated seismic activity. These studies assume a time-independent seismicity model and thus neglect earthquake inter actions: They do not consider the possibility of an aftershock cascade triggering scheme to explain the foreshock seismicity observed. In this study, we test the same catalog against the Epidemic Type Aftershock Sequence model that accounts for earthquake clustering. We use the tem poral version of the ETAS model to detect anomalous seismic activities before 53 mainshocks between 2008 and 2017. We find that less than 5 out of 53 selected mainshocks (10%) are preceded by significantly elevated seismicity rates. This suggest that foreshock observations can generally be explained by background seismicity and by cascades of earthquakes even in highly complete earthquakes catalogs.

Insight on rupture dynamics from probabilistic fault models of the 2014 Iquique earthquake

Emmanuel Caballero, Zacharie Duputel, Aochi Hideo, Harsha Bhat, Nicolas Brantut, Romain Jolivet.

Institut de Physique du Globe de Strasbourg (UMR 7516 CNRS), EOST/Université de Strasbourg, France.

ecaballeroleyva@unistra.fr

A common way to characterize seismic sources is to estimate the history of fault slip from observed co-seismic displacements. This type of modeling is usually termed "kinematic" because it does not address the underlying failure mechanism on the seismic fault. These kinematic models can then be used to inform dynamic models of fault behaviors that explicitly consider the stress associated with fault slip. To get insight on rupture dynamics, a possibility is to use kinematic models as a boundary condition to compute the temporal stress evolution on the fault (e.g., Tinti et al., JGR 2005). We explore the stress evolution observed from kinematic models of the 2014 Mw=8.1 Iquique earthquake. This study is carried out in a Bayesian framework, where several kinematic model samples describe our knowledge of the rupture process given available observations. To calculate the shear traction, we solve a boundary integral equation method (BIEM) using slip rate history derived from kinematic model samples. The retrieved shear traction evolution shows slip weakening relation, hence we estimate the critical slip weakening distance (Dc) and the breakdown work (i.e., area under the stress-slip curve up to minimum traction). Preliminary results for the 2014 Iquique earthquake indicate an almost linear dependence of Dc with total slip. As mentioned in previous studies, our resolution on Dc is probably very poor given the filter bandpass used for inversion (5-100 sec). Breakdown work, on the other hand, appears to be stably estimated despite the non-uniqueness of other dynamic parameters. Therefore, we focus on scaling relationships between breakdown work and kinematic parameters such as slip amplitude and rupture velocity. This analysis is then compared with typical scaling relationships expected for crack-like and pulse like ruptures.

Cooking synthetic rocks in the laboratory: preparing “sandstones” with known microstructural attributes

L. Carbillet[1], M. Heap[1], P. Baud[1], F. Wadsworth[2], and T. Reuschlé[1]

[1]Institut de Physique du Globe de Strasbourg (UMR 7516 CNRS), EOST/Université de Strasbourg, Strasbourg, France. **lcarbillet@unistra.fr**

[2]Department of Earth Sciences, Durham University, Durham, United Kingdom.

Regardless of their composition and microstructure, sandstones in the Earth’s crust are subject to a variety of geological processes and deformation mechanisms. However, microstructural attributes play a key role in the manner and extent to which sandstones react to these processes. Therefore, understanding the influence of microstructural geometries on the hydromechanical behaviour of sandstones is necessary to improve model predictions, which are routinely used in many aspects of geoscience and engineering. While studies using theoretical or experimental approaches have successfully provided a good understanding of the key control of microstructural parameters such as porosity on the hydraulic and mechanical properties of sandstones, the deconvolved influence of the multitude of microstructural parameters remains unclear. Until now the study of the role of a specific microstructural attribute in isolation has relied heavily on numerical modelling, without the necessary experimental validation. To address this shortcoming, we created precisely controlled synthetic samples by sintering glass beads. The sintering process allow us to control porosity and grain size independently, so that we could deconvolve these microstructural parameters and parameterise specifically for their importance. Our results demonstrate that the trends in porosity, permeability, and P- and S-wave velocity for our synthetic samples are similar to those reported for natural sandstones. Moreover, the mechanical behaviour of the synthetic samples is similar to that of natural sandstones. We were able to reproduce the typical failure modes of sandstones in our synthetic samples during compression tests: brittle failure at low confining pressure and the transition to a ductile failure mode at higher confining pressure, including the formation of compaction bands. Our study thus demonstrates the possibilities that lie in creating synthetic samples using sintering and opens up new perspectives for unravelling the contribution of microstructural attributes on the mechanical and hydraulic properties of granular rocks such as sandstones.

The tectono-stratigraphic and magmatic evolution of conjugate rifted margins: insights from the NW South China Sea

Peng Chao[1], Gianreto Manatschal[1], Pauline Chenin[1], Jianye Ren[2], Cuimei Zhang[3],Xiong Pang[4], Jingyun Zheng[4], Linlong Yang[5] and Nick Kusznir[6]

[1] Institut de Physique du Globe de Strasbourg, UMR7516, Strasbourg, France
[2] College of Marine Science and Technology, China University of Geosciences, Wuhan, China
[3] Southern Marine Science and Engineering Guangdong Laboratory, Guangzhou 511458, China
[4] CNOOC Ltd.-Shenzhen, Branch, Shenzhen,518054, China
[5] Working Station for Postdoctoral Scientific Research, Shengli Oilfield, Dongying, 257001, China
[6] School of Environmental Sciences, Liverpool University, Liverpool, United Kingdom

c.peng@unistra.fr

This study is based on a careful analysis of the high-quality, reflection seismic section CGN-1 located at the tip of the NW South China Sea propagator. The CGN-1 section is one of the rare champion lines imaging the complete tectono-sedimentary and magmatic architecture of a pair of conjugate rifted margins. The study provides a detailed description of the crustal architecture, defines extensional domains, determines the tectono-sedimentary and magmatic evolution and proposes a kinematic restoration using a methodological approach, which enables to quantify amount of extension and strain rates. The kinematic evolution linked to three, in sequence oceanward stepping fault systems, is connected to the stratigraphic and magmatic record through a Wheeler approach. This approach is used for the first time to decipher the tectono-magmatic and sedimentary evolution of a complete syn-rift mega-sequence imaged in a seismic section across a conjugate rifted margin. Based on identifying and characterizing distinct stratal patterns and crustal architectures, this study proposes qualitative and quantitative criteria to interpret two critical rifting events, which are necking and hyperextension that are linked to the individualisation and subsequent dismembering of an H-block. The results presented in this study challenge previous interpretations of correlative surfaces by introducing different types of top basement and distinguishing between syn-tectonic package and syn-rift tracts. This approach leads to new interpretations for the tectono-stratigraphic and magma evolution of the NW South China Sea and has the potential to be used as a new approach to analyse, quantify and correlate events recorded in seismic sections across rifted margins worldwide.

Active Tectonics, Crustal Deformation and Seismotectonic background for a realistic Seismic Hazard Assessment in southern Africa

Thifhelimbilu Mulabisana[1,2], Mustapha Meghraoui[1] and Moctar Doucoure[2]

[1] Institut Terre et Environnement Strasbourg, CNRS-UMR 7516, University of Strasbourg, 4 Rue René Descartes, 67084 Strasbourg, France

[2] AEON-ESSRI, Nelson Mandela University, University Way, Summerstrand, Port Elizabeth, 6019, South Africa

mulabisana@etu.unistra.fr

The identification and detailed mapping of historical and Quaternary surface faulting in many zones of neotectonic and earthquake activity have led to recent improvements in the seismic hazard studies. In southern Africa, past earthquakes and the seismic activity document the existence of seismically active faults but without enough data on their tectonic and physical characteristics and significance. Therefore, the seismic hazard assessment has been mostly based on statistical inferences, thus heavily dependent on seismicity catalogues which are incomplete and earthquake distribution biased by the lack of precise earthquake locations (error >5 km). We study the southern Africa regions by detailed investigations on active faulting, crustal deformation and seismotectonic structures so to enhance the seismic assessment. In this context, active zones with recent large earthquakes are selected such as the 2017 Moiyabana earthquake (Mw 6.5, Botswana), 1932 St Lucia (M_w 6.5, South Africa) and 1969 Ceres-Tulbagh (M_w 6.3, South Africa). The seismotectonics of Moiyabana 2017 earthquake focuses on aftershock distribution combined with InSAR and tectonic geomorphology. Whereas the St Lucia 1932 earthquake focuses on damage distribution, tectonic geomorphology and the analysis of waveform records collected from several agencies. Our subsequent objective is the integration of the new seismotectonic data into the seismic hazard and risk evaluation in southern Africa.

Keywords: Seismotectonics, seismic hazard, earthquake.

Theme 3 : Near-surface hydrology: from the lab to the global scale.

Modeling and Inversion of GPR Signals for Estimating Hydraulic Properties of Unsaturated Sandy Soils

Minghe ZHANG[1,2], Maksim BANO[1], Xuan FENG[2]

[1]IPGS-EOST, CNRS-UMR 7516, University of Strasbourg, Strasbourg, France
[2]College of Geo-exploration science and Technology, Jilin University, Changchun, PRC

minghe.zhang@unistra.fr

The evaluation of soil hydraulic properties is important in many areas like hydrology, agriculture and soil science. Over the last years, GPR has been widely applied for estimating soil hydraulic properties, because of the noninvasive comparing with the traditional equipment for estimating soil hydraulic properties like TDR.

The object of this thesis is that estimating soil hydraulic properties in unsaturated sandy soils by using GPR. At present, we have realized two experiments. And we finished estimating the water content by modeling and inversion of GPR signals. The first experiment is the imbibition and drainage experiment and the second experiment is the infiltration experiment. We realized the inversion of the water content by comparing the modeling signal with the real signal and backing to modify the water content model. Comparing the GPR inversion results of the water content with the water content measured by TDR (Provided by Oliver RAZAKARISOA), we concluded that GPR is a good method to realize the inversion of the hydraulic parameters. And we can monitor the water flow by comparing the change of the water content from the GPR inversion results at different time.

The GPR method is a good method for realizing the inversion of the hydraulic parameters and the monitoring of water table and water flow. In the future, we will apply the inversion algorithm to realize the inversion automatically and estimate the soil hydraulic properties.

Keywords: Ground penetrating radar; Modeling and inversion; Hydraulic Properties; Unsaturated Sandy Soils

Study of the accuracy of GRACE products
Magnetic, gravimetric and geodetic constraints on the dynamics of the fluid core

Hugo Lecomte, Sévérine Rosat, Mioara Mandéa

Intistut Terre Environnement Strasbourg (ITES), University of Strasbourg;
Centre National D'études Spatiales.

hugo.lecomte1@gmail.com

A six-year oscillation was previously found in length-of-day variation. This signal was attributed to an angular momentum exchange between the core and the mantle. Processes in the Earth's core are complex and could possibly be related to interannual oscillations in gravimetric, GNSS displacements and geomagnetic observations. The main goal of this thesis is to investigate the consistency between these observables, their correlation and their possible link with core processes.

Variations in the Earth's gravity field are monitored with increasing accuracy by space geodetic measurements. We first focus on gravimetric observations with GRACE satellites that contain diverse information such as hydrology, atmospheric or post-glacial rebond signals. A first step is to correct GRACE data from those geophysical and surficial processes to access the Earth core signal. Accuracy of this final product must also be evaluated. The GRACE mission has suffered a lot of issues such as accelerometer failures and it leads to a need for data corrections. GRACE data are coming from multiple analysis centers with different processing software and strategies. A comparison of these various GRACE products and their consistency is then necessary. It turns out that standard products have an agreement within 3 centimetres on average. However, GRACE products from the CNES analysis center have the largest deviation according to standard products with a 5-centimetre difference on average. The mass concentration (mascon) products are also compared with the standard Stokes coefficients solutions. A difference of 10 centimeters in equivalent water thickness is observed with respect to classic products.

Surface seasonal deformations in western Europe computed from a massive GNSS processing of a global network with the GINS/PC software

Alexandre MICHEL[1], Jean-Paul BOY[1], Félix PEROSANZ[2]

[1]IPGS, UMR 7516 CNRS/Université de Strasbourg
[2]GET, UMR 5563 CNRS/Université Paul Sabatier/CNES/IRD

alexandre.michel@unistra.fr

We first process the GNSS solution of a massive European network containing almost a thousand stations over twenty years, using a Precise Point Positioning (PPP) approach with the GINS/PC software developed by the CNES/GRGS. The products used are also compatible with an Integer ambiguity fixing (IPPP) which allow a reduction of RMS until 30% on the horizontal components. Nevertheless, these products need to be aligned with the International reference Frame (ITRF) that we compute with the CATREF software. We then characterize the spatio-temporal variability of the time series especially the seasonal variations (which is mostly annual) using a Principal Component Analysis approach and periodogram representation. We also studied the viscoelastic Love number computation and the effect of different rheologies of the mantle which can slightly affect the load recovery. Several tests have been realized to evaluate the effect of rheology on the long period tidal waves, the Glacial Isostatic Adjustment, and annual and secular hydrological signal supplied by GRACE-CSR data. The whole studies conducted should improve the inversion process (find optimum smoothing parameters and use more precise spatial rheological models) of the GNSS displacement to recover the applied surface mass load in order to compare the local hydrology data, GRACE signal and several hydrological models.

Keywords: GNSS; Surface loading; Love numbers; Regularized least square inversion;

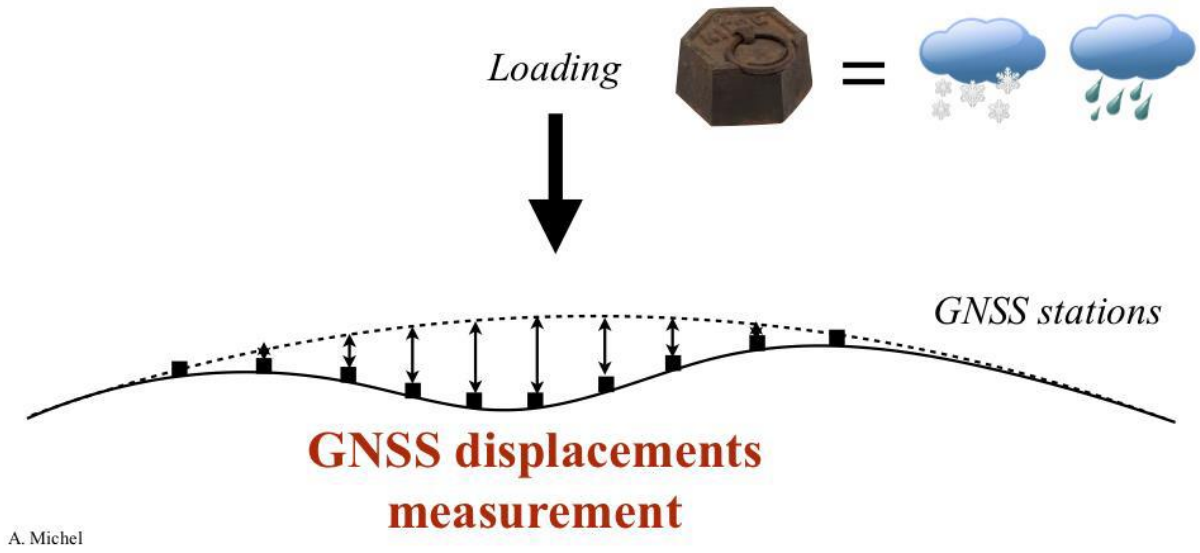


Figure 1: Schema of the loading processing on the Earth Surface and the measurement of the induced displacement by a dense GNSS network.

Time-lapse gravimetry as a tool to calibrate a physically based distributed hydrological model

Quentin CHAFFAUT[1], Nolwenn LESPARRE[2], Jacques HINDERER[1], Frédéric MASSON[1]

[1] IPGS-EOST, CNRS-UMR 7516, CNRS/Université de Strasbourg, 67084 Strasbourg, France.
[2] LHyGeS-EOST, CNRS-UMR 7517, CNRS/Université de Strasbourg, 67084 Strasbourg, France

qchaffaut@unistra.fr

Springwater is the only drinking water resource available in mountains. It is indispensable for local agriculture, industrial water supply and municipal water supply, but mountain water is also an important source of freshwater for the adjacent lowlands. Water storage dynamics of mid-altitude mountainous catchments is particularly sensitive to small changes of climate forcing (precipitation regime, air temperature). In the northeastern part of France, climate change is expected to induce a rise in mean temperature of more than 2°C and a significant change in precipitation regime during the 21st century, which is questioning the sustainability of water resource of vulnerable mountain hydrosystems.

Physically based distributed hydrological model are key tools to assess hydro-systems dynamic and hence they can contribute to quantify their vulnerability. However, such models are usually difficult to calibrate because of the lack of observational constrains. Here we show that time-lapse gravimetry is a valuable tool to calibrate a distributed hydrological model (NIHM for Normally Integrated Hydrological Model) applied to the study of the Strengbach mountain catchment (Vosges mountains, France). In particular, we demonstrate that: i) gravimetry is sensitive to NIHM parametrization and ii) gravimetry allows us to identify preferential water storage area within the Strengbach catchment. Our study therefore indicates that gravimetry is a promising tool to calibrate distributed hydrological model, especially since it is a cost-effective and non-intrusive method, in contrast with the traditional calibration approach which rely on observation wells.

Keywords: Time-lapse gravimetry, hydrological model calibration, water resource, mountain catchment

Figure 1 The Vosges mountains

Hydrodynamic and thermodynamic simulation in the Strengbach catchment

Daniel Steven MORENO MARTIN, François Chabaux, Phillipe Négrel, Phillipe Ackérer

LHyGeS-EOST, CNRS-UMR 7517, CNRS/Université de Strasbourg, 67084 Strasbourg, France

dsmorenomartin@unistra.fr

Temperature measurements of air, soil and springs in the Strengbach catchment, northeast of France, exhibit a change in the heat variation amplitudes as well as a shift between the atmospheric heat and the shallow underground soil and water.

The computer program TRACES was used to simulate the hydrodynamic and thermodynamic behavior of a two-dimensional soil layer model corresponding to the vadose zone under a slope of the Strengbach catchment for the period from 10/09/2013 to 01/01/2017. The boundary conditions for the flow is equal to the vertical drainage obtained from the balance water model BILJOU; while the thermal boundary conditions are established for the surface as the air temperature records for the studied period, and for the low limit a constant temperature of 7° is set up corresponding to the geothermal heat flow. The model was validated by comparison with measured temperatures in the springs CS1, CS2, CS3, CS4. A sensibility analysis was also carried out to observe the influence of several soil parameters (saturated water content, thermal conductivity of solids, saturated hydraulic conductivity) as well as the boundary conditions (precipitation, thermal boundary) in the thermal response of the catchment.

Preliminary results have shown that heat conduction in the soil produces an increasing attenuation of the air temperature variations along with a more delayed response when temperatures are obtained deeper, in contrast the influence of heat transfer by flow (convection process) was observed to be negligible. The main parameter controlling the thermal response is the saturated water content, however the thermal boundary conditions control the simulations average temperature and the attenuation of heat in depth.

Development of the integrated hydrological model NIHM: Implementation of transport processes

Mouna Chaguer, Sylvain Weill[1], Philippe Ackerer[1], Frederick Delay[1]

[1] Laboratoire d'Hydrologie et Géochimie de Strasbourg,
University of Strasbourg/EOST/ENGEES, CNRS UMR 7517,
1 Rue Blessig, 67084 Strasbourg, France

mchaguer@unistra.fr

An integrated hydrological model called NIHM (Numerical Integrated Hydrological Model due to the integration of 3D underground processes into a 2D formalism) was developed at LHyGeS and couples a low-dimensional (2-D) subsurface model to 1-D river flow and 2-D overland flow. We present an approach in which a transport scheme is implemented in NIHM in order to show that we can describe the transport processes in a watershed while applying the depth integrated approach especially for the subsurface. Therefore, NIHM is non-intrusively coupled with the TRACES model (Reactive Transport of Contaminants in Groundwater), which is developed at LHyGeS to describe stationary or transient flow-transport calculations in 2-D or 3-D domains, based on the complete resolution 3 -D of the Richards equation and the advection dispersion equation. This transport scheme is first applied on synthetic test cases in order to properly assess the impact of the integration of a 3-D Richards equation along a local direction normal to the bottom of the aquifer on the simulated transport results. This exercise aims to compare the coupled NIHM - TRACES model with the TRACES model, for the purpose of evaluating the coupled model's ability to describe solute transport processes in regard to cases with complex geometry, heterogeneous hydraulic conductivity field of the subsurface compartment, and various interactions between the surface and the subsurface. The coupled NIHM - TRACES model is then applied to describe transport processes in an actual restored hydrosystem namely, Rohrschollen Island of the Upper Rhine River, based on real data, in particular heat transfers between surface and sub-surface under highly transient hydrological conditions.

Keywords: Low-dimensional model; Advection-dispersion equation; Transport scheme; Non intrusive coupling

Theme 4 : Anthropogenic impact on the environment: make landscape, air and water quality great again !

Analysis of energy transition in the Trinational Metropolitan Region Oberrhein (TMO) region

Marco GUEVARA[a], Adrien BARTH[a], Nadège BLOND[a], and Alain CLAPPIER[a]

[a]Laboratoire Image Ville Environnement (LIVE),
Université de Strasbourg. Strasbourg 67000, France.

guevaraluna@unistra.fr

The Trinational Metropolitan Region Oberrhein (TMO) looks for the decarbonization in line with the Paris Agreement and the EU's objectives to reduce greenhouse gas (GHG) emissions by 80-95% by 2050. This led to the implementation of energy transition policies to effectively tackle climate change by increasing the energy generation from renewable energy sources (RES). This research aims to develop a methodology for the evaluation of the energy transition yearly scenarios based on the Regional Energy Planning Model (REPM). REPM is a top-down model oriented to simulate on-grid systems, this model can evaluate the intermittency, and hourly variations, of the electricity demand and RES production during 1-year long periods of time for a defined region or country. An initial estimation of the surface required to install new RES infrastructure shows that wind requires more surface than solar to be implemented in the TMO region, but solar requires larger storage capacity. Additionally, if storage is not implemented, the backup (e.g. local or external conventional energy sources, and external RES) cannot be reduced to zero. If a large RES share is introduced into the energy mix, the intermittency of the energy supplied to meet the electricity demand leads high-power and fast response backup needs; additionally, the needs of backup and storage technologies with fast start-up and response times might be necessary.

Reactive transport of dichloromethane and micropollutants in laboratory aquifers: an integrative approach

Maria Prieto-Espinoza[1], Sylvain Weill[1], Benjamin Belfort[1], François Lehmann[1], Emilie Müller[2], Stéphane Vuilleumier[2], Gwenaël Imfeld[1]

[1] Laboratory of Hydrology and Geochemistry of Strasbourg (LHyGeS - UMR 7517), University of Strasbourg/ENGEES, CNRS, Strasbourg 67000, France
[2] University of Strasbourg, CNRS, (GMGM - UMR 7156), Strasbourg 67000, France

prietoespinoza@unistra.fr

Groundwater quality is of increasing concern due to the ubiquitous release of many substances in the subsurface. Although biodegradation is a major process for the removal of organic contaminants in polluted aquifers, the interplay of dynamic hydrogeochemical conditions, microbial diversity and contaminant dissipation is yet poorly understood. An integrative approach is required to understand the reactive transport and factors affecting the degradation of both industrial contaminants and micropollutants. Compound-specific isotope analysis (CSIA) is increasingly used to evaluate contaminant transformation *in situ* based on changes in the ratio of stable isotopes (e.g., $^{13}C/^{12}C$) of an organic contaminant undergoing a degradation reaction. The responses of aquifer microbes – the key players during contaminant biodegradation – is of relevance thus biomolecular approaches are commonly applied at contaminated sites. The implementation of numerical models, in addition to analytical techniques, allows monitoring and predicting contaminant transformation *in situ*.

In this study, we examined the reactive transport of dichloromethane (DCM) and micropollutants in two lab-scale aquifers under near-natural settings. First, we examined DCM degradation, a volatile and toxic industrial solvent frequently detected in multi-contaminated aquifers, under steady-state and water table fluctuating conditions. DCM degradation was more pronounced under water table fluctuations (97%) compared to steady-state conditions (41%). Based on C and Cl isotope composition, two distinct DCM degradation pathways were observed under the two flow regimes. Second, the dissipation of a micropollutant mixture was examined under steady-state conditions during short- and long-term exposures. Linear sorption and low isotope fractionation (< 2‰) were observed indicating their high persistence and the risks to long-term groundwater contamination. A two-phase flow model (i.e., water and gas) was developed to predict DCM dissipation accounting for water table fluctuations and the associated transport processes. Overall, our integrative approach enables to assess natural attenuation of DCM at contaminated sites accounting for dynamic hydrogeological conditions. This model will be further adapted for the reactive transport of micropollutants in groundwater.

Keywords: Dichloromethane, micropollutants, isotope fractionation, degradation pathways, RTM

Geohistory and geoarchaeology of agrarian landscapes in Grand Est : Shapes, plots and territories.

Benjamin Keller[1], Dominique Schwartz[1], Damien Ertlen[1]

[1]LIVE - CNRS / University of Strasbourg, France

benjamin.keller@live-cnrs.unistra.fr

In this doctoral project in geography, we propose to look at the agrarian shapes of the past and their legacies in the contemporary landscapes of the Grand Est region. In Europe, the vast majority of landscapes are the result of a co-construction between Nature and human. Until the middle of the XXe century, the men who carved the landscape were mainly farmers, organized according to the times collectively and under the aegis of seigniorial or ecclesiastical authorities. In this context, the study of agrarian landscapes makes it possible to better understand human dynamics and their consequences on the temporal trajectories of the Grand Est territory. Indeed, agrarian landscapes are often summarized as openfields and bocage systems. However, many agrarian forms such as **lynchets**, **ridge and furrow** and **murgers**, attest to a complexity that cannot be satisfied with a two-dimensional reading of the rural landscape. In the field, we analysed agrarian shapes located in Haut Rhin (68), Bas Rhin (67) and Moselle (57). A **Lynchet** is a kine of bank that appears on a slope, which results, in most cases, from the erosion of the soil of the plot caused by colluviation or by tillage erosion and sediments accumulation behind a hedge, a pile of stone, a wall... Unlike terraces, lynchets are involuntary forms and not a construction. Indeed, each lynchet corresponds to a plot whose bank represents the limits that allowed the installation of a hedge. ***Ridge and Furrow*** is the result of the utilization of mouldboard plough stationary (≈10thcentury) and the plowing technique known as "ados". This technique consists of plowing starting from the middle of the field between two plot boundaries, then turning around the first plowing favoring the accumulation of soil at the center thus creating a ridge. A "***Murgers***" are the results of the removing and the stacking of plots stones on the plots border. Removing stones, in order to make the cultivation of the lands possible. Mostly of this agrarian shapes probably appears during the middle Age. The analysis of these shapes at the local level makes it possible to estimate their dynamics. This study is based on several disciplines (pedology, anthracology, geography, history) in order to acquire as much complementary data as possible on agrarian shapes.

Keywords: Agrarian shapes, landscape dynamics, Murger, Lynchet, Ridge and furrow, pedoanthracology, middle Age.

Industrial releases and its impact on the Upper Rhine river: geo-history and legal approaches

Ly keng Caline[1], Badariotti Dominique[1], Berrod Frédérique[2]

[1]Laboratoire Image Ville Environnement (UMR 7362), Université de Strasbourg, Strasbourg
[2]Centre des études internationales et européennes (CEIE), Université de Strasbourg, Strasbourg

caline.lykeng@live-cnrs.unistra.fr

The Rhine river is used for navigation, irrigation, production of electricity, drinking water but also for the disposal of industrial and urban releases. The Rhine river also provides important habitat for the ecosystems. However, in the past, the Rhine river was so polluted especially by industries released that it was once called "the open sewer of Europe". The main goal of this study is to question if the struggle against the pollution of the Rhine river can be ensured by legal mechanism in a context of industrial releases authorisations since the XXth century. Indeed, many legal acts such as international agreements, directives of the European Union and intern laws, have been adopted in order to reduce water's pollution by industries. The transboundary water cooperation which is based on shared historical legacy of water governance also allowed the improvement of the Rhine river's water quality over the time. However, industries are still allowed to release wastes into the water after the approval of the administration even though parameters and their amounts are controlled. Researches in archives show us that pollution in the Rhine was legitimize for the sake of economy for a long time and sometimes the administration was willing to make regulations less strict by increasing the threshold values because industries could not comply with the demand of initial threshold values. The analysis of the evolution of law show how threshold values are more and more included into legal acts and thus how science could be used for others interests. In this study we reconstruct the geo-history of industrial pollutions and assess the effectiveness of law with the help of numerical data bases. Indeed, this research aims to understand better the relation between law and industrial releases by studying the trajectories of the pollutants regulated by European law with the case study of the Upper Rhine

Keywords: Rhine river; water's pollution; geo-historical; environmental law

Management and ecological restoration of the protected areas of the “Bande rhénane”: construction of a participatory and adaptive methodology

Osorio Angela[1], Meinard Yves[2], Schmitt Laurent[1], Badariotti Dominique[1]

[1]Laboratoire Image Ville Environnement (LIVE UMR 7362), University of Strasbourg, France
[2]Laboratoire d'Analyse et de Modélisation de Systèmes pour l'Aide à la Décision (LAMSADE UMR CNRS 7243) University of Paris-Dauphine

angela.osorio@live-cnrs.unistra.fr

Humanity has profoundly changed the planet, affecting biodiversity, the dynamics of ecosystems and, consequently, the services they provide to societies. This situation has led to the implementation of environmental conservation strategies in which "Protected Areas" ("PAs") have occupied a central place at all scales since the 19th century. In France, the trend has been to create PAs and to increase the number of types of protection. The aim of this thesis is to understand which types of management and ecological restoration are carried out in the PAs of the “Bande Rhénane” (“PABR”) and what contribution participatory and adaptive approaches could contribute to improved management and restoration practices. Five data collection techniques were used in this thesis: document review, direct observation, semi-structured interviews, focus groups, and questionnaires. For the use of these different techniques, we relied on the triangulation method. The main results of this thesis are: i) the reconstruction of management and restoration trajectories of PABR; ii) the identification and analysis of stakeholders and discourses related to the management and restoration of PABR ; iii) the analysis of management and restoration tools; iv) the collaborative application of a participatory and adaptive approach to the management and restoration of a National Nature Reserve; and v) recommendations for improving management and restoration practices of PABR based on a participatory and adaptive approach. This thesis in human geography focuses on the management and restoration of protected areas of the PABR and discusses how to improve these practices based on a participatory and adaptive approach.

Modeling of physico-chemical processes impacting the concentration of particles in indoor air: assessment with experiments in simulated atmosphere chambers

Corentin Berger[1,2,3], Nadège Blond[1], Maxence Mendez[3], Alice Micolier[3], Didier Hauglustaine[4] et Jean-Luc Ponche[1]

[1]Laboratoire Image, Ville et Environnement, UMR 7362 CNRS-Université de Strasbourg, France

[2]French Environment and Energy Management Agency, Angers, France.

[3]Octopus Lab, La Madeleine, France

[4]Laboratoire des Sciences du Climat et de l'Environnement, UMR 8212 CEA-CNRS-UVSQ, Gif-sur-Yvette, France

corentin.berger@live-cnrs.unistra.fr

The time spent in indoor environments varies between 80 and 90%. An individual breathes about 15 kg of air per day. This air is often more polluted inside than outside (WHO, 2014), due to the the presence of sources of emissions related to construction or decoration materials, occupants' activity and sometimes poor ventilation.

Conventional IAQ diagnostics based on measurements are expensive and time-limited. IAQ models are emerging to offer new evaluations of indoor pollutant levels but the quality of the simulations mainly depends on the quality of input data.

The INCA-Indoor model was developed to understand the measurements of pollutant concentrations in gaseous and particulate phases by integrating the physico-chemical process. It now allows to carry out IAQ studies in support of building design projects (www.octopuslab.fr). The model showed good agreement in reproducing the gas phase (*Mendez et al., 2015, 2016, 2017*). The robustness of INCA-Indoor in modelling for particulate concentration is currently evaluating: simulation results are compared against experiments in simulation chambers. Two types of aerosols were selected to cover all the processes: Diesel soot and Secondary Organic Aerosol (SOA).

Keywords: Aerosol, Secondary Organic Aerosol, Coagulation, Condensation, Nucleation, Building, Indoor Air Quality, Atmospheric simulation chamber

II. Poster presentations 09/02/2021

Session 1 :

Improvements in Reactive Transport Models for electro diffusion process in porous media based on Nernst-Planck-Poisson Equation

Sara Tabrizi Nejad As[1], Jerome Carrayrou[1], Maarten W. Saaltink[2,3], Marwan Fahs[1]

[1] *Laboratoire d'Hydrologie et Geochemie de Strasbourg, University of Strasbourg/EOST/ENGEES, CNRS, 1 Rue Blessig, 67084 Strasbourg, France*
[2]*Department of Civil and Environmental Engineering (DECA), Universitat Politècnica de Catalunya, Barcelona, Spain* [3]*Associated Unit: Hydrogeology Group (UPC-CSIC), Spain*

sara.tabrizi-nejad-as@etu.unistra.fr

In a multicomponent electrolyte solution, each individual dissolved species can migrate differently according to its own ionic properties. This process is called electrochemical migration and it cannot be fully described by Fick's law in which the ionic movements are merely based on the gradient of concentration. Therefore, in the studies regarding to electrochemical migration, Fick's law is substituted by Nernst-Planck equation.

The common approach for solving this system is based on null current assumption which expresses the electric potential in terms of charges and concentrations of chemical components. This assumption has a great advantage as it eliminates the electric potential from Nernst-Planck equation. However, null current assumption limits the ability of the model to describe a domain subjected to an external electric field. Even without external field, the validity of the null current assumption could be questionable. This topic has never been investigated in the past. We aim to evaluate the validity of null current assumption and understand its effect on reactive transport processes.

Thus, we introduce a new reactive transport model that allows for an accurate representation of the electrochemical migration process. The developed model is based on the Nernst-Planck and Poisson equations (NPP) equations which are solved together. We also implement model based on the null current assumption. The new developed models (with and without null current assumption) have been validated by comparison with several benchmarks. Our results show that in the case of high sorption rate, the null current model is no longer valid. Therefore, on the cases including sorption the new model is introduced as a substitution to the common approach of null current assumption.

Joint Inversion of Passive Geophysical Data: Magnetotelluric and Ambient Seismic Noise

Mónica Aquino[1], Guy Marquis[1] and Jerome Vergne[1]

[1] Université de Strasbourg, CNRS, ENGEES, Institut Terre et Environnement de Strasbourg, UMR 7063

maquinoguerra@unistra.fr

Accurate characterization of the subsurface requires the integration of multiple geophysical information, which can be done through joint inversion. The basis of any joint inversion method is the existence of functional links between the multiple model parameters. The two main joint inversion approaches are through structural or petrophysical relationships. Joint inversion using correspondence maps combines the advantages of jointly estimating geophysical models and parameter relationships. In this work, we use a correspondence map approach to invert jointly surface-wave dispersion curves and magnetotelluric data for subsurface shear velocity and resistivity but also for a possible relationship between them. By inverting synthetic data, we show that when this relationship is linear, we can recover both the geophysical models and the relationship parameters. We also show that the approach is successful when seeking higher-order relationships.

Keywords: joint inversion, correspondence maps, passive data, structural coupling, petrophysical coupling.

Anisotropy of hydraulic diffusivity due to fracture surface roughness and fracture closure

Q. Deng[1], J. Schmittbuhl[1], G. Blöcher[2]

[1] EOST-IPGS, Université de Strasbourg/CNRS, Strasbourg, France

[2] GFZ German Research Centre for Geoscience, Potsdam, Germany

dengq@unistra.fr

Hydraulic diffusivity can be used to relate the distance from the injection center with injection time in the distribution of induced seismic events (Shapiro et al., 1997). Besides, it is a key parameter in linear pressure diffusion equation in the context of poro-elasticity that related to temporal and spatial derivatives of fluid pressure. Since fractures dominate the fluid flow in impermeable rock mass, the hydraulic diffusivity of natural fractures is of great importance. To quantify it, we conducted numerical simulations of transient fluid flow in a single fracture at the reservoir scale (~ 500 m). We built synthetic fracture apertures from a self-affine model with isotropic Hurst exponent derived from fault surface observations (Candela et al, JGR, 2012). An effective hydraulic diffusivity of the fracture was estimated by fitting the pressure field with the analytical solution of an equivalent parallel plate model (i.e., with the same mean aperture). We performed the forward pressure diffusion modeling in rough fractures and observed that the roughness could affect the pressure diffusion in the fracture, which is manifested as an increase or decrease in the effective hydraulic diffusivity. As we closed the fracture, the effective hydraulic diffusivity decreases and deviates more and more from the parallel plate model predictions. Furthermore, based on a fully plastic model of the asperity contact, we observed that when closing the fracture to the fluid percolation threshold, the effective diffusivity of the fracture decreases by 7 and 5 orders of magnitude in x and y direction, respectively. Such anisotropy may have strong implications to the distribution of fluid-induced seismicity.

The role of the environment in the social inequalities in the physical activities of pregnant women residing in the eurometropole of Strabourg – (ENVIFEM)

Virginie Hamann [1,2], Philippe Deruelle[2], Christophe Enaux[1], Séverine Deguen[3] and Wahida Kihal Talantikite[1]

[1] LIVE UMR 7362 CNRS (Laboratoire Image Ville Environnement), University of Strasbourg, Strasbourg

[2] University Hospitals of Strasbourg, Strasbourg

[3] EHESP Rennes, UPMC-INSERM, Institut Pierre Louis d'Epidémiologie et de Santé Publique (UMRS 1136), Paris

virginie.hamann@live-cnrs.unistra.fr

Excessive weight gain during pregnancy can promote later obesity, leading to complications during pregnancy, such as gestational diabetes, hypertension and pre-pregnancy eclampsia, which affect the growth of the fetus. The primary determinant of excessive weight gain is related to a healthy living environment and physical activity.

Our main objective is to study the role of the living environment in the practice of physical activity by pregnant women and to identify the socio-environmental construction that contributes to the disparities in this practice during pregnancy.

This is a prospective observational cohort study. Pregnant women will be included in the study during their first or second trimester ultrasound scan in the Hautepierre and CMCO ultrasound service from January 1, 2021 to January 31, 2022. The criteria for inclusion are: living in the Eurometropolis of Strasbourg, not being opposed to research, giving birth in Strasbourg University Hospitals, understanding the French language. Similarly, the exclusion criteria are obstetrical pathologies that are counter-indicative to the practice of physical activity, underage women.

The data collected will come from a questionnaire survey, health data and a characterisation of the physical, economic and social environment. This thesis is based on an innovative approach in France, combining both epidemiological and geographical approaches in statistical models.

Desirable Cities

John Villar

LIVE UMR 7362 CNRS (Laboratoire Image Ville Environnement), University of Strasbourg, Strasbourg

john-alexander.villar-pena@etu.unistra.fr

People use spaces based on their perceptions and experiences. These perceptions and experiences also contribute to the development of one's desire which, in turn, influence the way users interact with spaces.

We propose to explore desire in the context of urban use with a focus on (1) public places in megacities on one hand and (2) urban planning, development and design of the same public places on the other hand. To study both the designer's desire and the user's desire, it is fundamental to analyse the environment in which these desires manifest themselves.

The environment is understood in a broad sense where built or physical environment is a part of a larger environment that includes the media representation (from literature to social media). To analyse desire in this global urban environment as a system, we chose to create a twofold articulated theoretical framework built around the philosophical understanding of the environment by Peirce and the social structure theory of de Certeau.

Peirce argues that people's process of understanding the environment is semiotic with signs as the unit of three inseparable components: "Object", "Representament", and "Interpretant". The "Representament" is related to reading/decoding the environment, while the "Interpretant" is related to the behaviour of people within the environment. According to De Certeau, these behaviours can be categorized as strategical or tactical. "Strategy" and "Tactics" helps to understand the social hierarchy and objectives of the people who code and decode signs.

Articulating the semiotic system with this social hierarchy allowed us to create a model that is focused on the operations involved in the creation and interpretations of public spaces, with the goal of providing a catalogue of the desirable elements that people look for within their public spaces. We provide an example of such a model in the poster.

Anthropogenic trajectory in the Upper Rhine through the dynamics and the composition of the sedimentary deposits

Cassandra EUZEN[1,2], Laurent SCHMITT[1], François CHABAUX[2], Dominique BADARIOTTI[1]

[1]LIVE, CNRS-UMR 7362, Unistra, 67084 Strasbourg
[2]LHyGeS, CNRS-UMR 7517, Unistra, 67084 Strasbourg

cassandra.euzen@live-cnrs.unistra.fr

Over the last 200 years, the Upper Rhine river hydrosystem has been heavily anthropized with (1) the construction of major river facilities and (2) the development of potential sources of pollution resulting from industrialization, urbanization, agriculture and navigation. Within this framework, the project focuses on studying the anthropic impacts recorded in the sediments of the last 200 years, in order to retrace the history of the impacts of human activities on the banks of the river and in the catchment area.

The understanding of sedimentary dynamics allows to determine the fine-sediment-deposition-zones and the associated periods. This is achieved through a detailed study of the spatial evolution of the river (digitized old maps) and its incision/uplift (elevation of the thalweg, water and groundwater). This study, coupled with field visits, allows the location of several pits.

The sedimentary record thus selected are then subjected to a geochemical and sedimentological characterization, possibly isotopic. One hypothesis that will be tested here is that anthropogenic contaminations are concentrated in the paleo-channels filled during the 19th and 20th centuries. The study of spatio-temporal variations in the sedimentary record is based on the construction of a robust and precise age model based on the coupling of luminescence, isotopic and other methods (e.g. historical mapping, flood history). To study the impacts of human activities on the sediments, it is also important to define the natural geochemical background from ancient sediments (Holocene).

The results obtained for each area, compared with each other as well as with existing quality data (water, suspended matters, dredged sediments) will be interpreted using information on the history of human activities in the catchment area. This will allow to assess the potential of the sedimentary records in the understanding of the evolution of the Upper Rhine hydrosystem.

Keywords: river hydrosystem evolution – fluvial geomorphology - GIS - geochemistry - sedimentary

Estimation of groundwater storage using assimilating GRACE TWSA into hydrological model

Samira Sadat Soltani, *Marwan Fahs, Behzad Ataie-Ashtiani*

Laboratoire d'Hydrologie et Geochemie de Strasbourg, University of Strasbourg/EOST/ENGEES, CNRS, 1 Rue Blessig, 67084 Strasbourg, France

samira-sadat.soltani@etu.unistra.fr

Since water scarcity is a serious issue, it is essential to develop techniques e.g., hydrological modeling for monitoring and predicting water storage changes. However, inaccuracies and uncertainties in different aspects exist, e.g., simplification of meteorological physical processes, errors in climate forcing data and lack of data limit the reliability of hydrological models. Therefore, it is necessary to enhance the model performance by incorporating the new observations into the model dynamic, which is known as data assimilation. Satellite remote sensing data specially, Terrestrial Water Storage (TWS) data which can be obtained from Gravity Recovery and Climate Experiment (GRACE) provides a valuable source of data which can augment our understanding of the hydrologic cycle by integrating the new data into hydrological models. Assimilating GRACE TWSA into hydrological models can simulate missing water storage signals (e.g., anthropogenic) into the hydrological models, because it restricts the estimation of the summation of water storage changes (surface and sub-surface). Moreover, it improves the results of model simulations for different regions especially with limited ground-based measurements. Since GRACE TWS data has various error sources including correlated noise of high-frequency mass variations and spatial leakage errors, filtering GRACE TWS data is a difficult challenge as provision should be made for handling the errors and merging the data into the model.

In this thesis, a data assimilation framework is developed to merge remotely-sensed large scale TWSA with hydrological models. To implement this framework, CLM-ParFlow hydrological model is chosen, which is a sophisticated physical model that simulates daily water changes in surface and sub-surface water compartments (including groundwater). ParFlow solves the integrated three-dimensional Richard equation for subsurface flows.

Although a lot of studies have been performed and progress in data assimilation methods for merging GRACE TWS data and hydrological models has been made, most present data assimilation methods have some limitations. Therefore, the main objective of this project is proposing innovative GRACE TWS data filtering methods to use the potential of GRACE TWS data as much as possible and designing an innovative assimilation filter to not only improve the estimation of water storage states but also manage the dynamical balances of hydrological models.

Modeling of seawater intrusion in coastal aquifer at Kuwait City

Bashayer Alshammari, Marwan Fahs, Anis Younis

Laboratoire d'Hydrologie et Geochemie de Strasbourg, University of Strasbourg/EOST/ENGEES, CNRS, 1 Rue Blessig, 67084 Strasbourg, France

bashayer.alshammari@etu.unistra.fr

Groundwater is the only natural water resource in Kuwait and it is the most important component of drinking water production, as it is mixed with distilled seawater in a fixed ratio to produce drinking water. Groundwater pumping rates increased in Kuwait aquifers during the last two decades to meet the demand of drinking water and agriculture water. And due to the lack of natural replenishment from rainfall and the excessive pumping, ground water levels have declined significantly causing seawater intrusion in the coastal aquifer of Kuwait. As a result, many pumping wells have been terminated and replaced by new pumping wells and this condition is threatening ground water sources.

These scenario will worsen soon due to population growth, increasing urbanization and climate change associated with sealevel rise and decreased precipitation rates.

So the aim of my thesis is assessment of groundwater through the modeling of seawater intrusion in the main coastal aquifer in Kuwait City. Model applications are applied in two steps: calibration and validation of model simulations using COMSOL to assess the groundwater quality in the aquifer, predicting salinity state up to 2050 and suggest nature-based solutions to minimize the impact of the salinization of groundwater.

Session 2 :

Adverse Birth Outcomes Related to NO2 and PM Exposure

Valentin Simoncic, Christophe Enaux, Wahida Kihal

LIVE UMR 7362 CNRS (Laboratoire Image Ville Environnement), University of Strasbourg, Strasbourg

valentin.simoncic@live-cnrs.unistra.fr

There is a growing number of international studies on the association between ambient air pollution and adverse pregnancy outcomes. Our work try to assess association between maternal exposure during various windows of exposure during pregnancy to nitrogen dioxide (NO2) or particular matter (PM) and the risk of adverse birth outcomes, including low birth weight (LBW) and preterm birth (PTB). The exposure assessment will take into account the daily mobility of pregnant women. In another hand, this work try to assess variation in exposure depending on different socio-economic profile. For this purpose, we work with Amo Grand-Est and University hospitals of Strasbourg to create a cohort of pregnant women. The survey protocols were developing with Mme. Hamann who work on the same cohort (PhD student). The Investigation is expected to begin flowing January 2021.

I also work on a systematic revue with Christophe Enaux, Wahida Kihal and Severine Deguen. This study has been conducted focusing on European countries, to assess the crucial public health issue of this suspected association on this geographical area. A systematic literature search has been performed on all European epidemiological studies published up until 1 April 2020, on the association between maternal exposure during pregnancy to NO2 or PM and the risk of adverse birth outcomes, including LBW and PTB. Fourteen articles were included in the systematic review and nine of them were included in the meta-analysis. Our meta-analysis was conducted for 2 combinations of NO2 exposure related to birth weight and PTB. Our systematic review revealed that risk of LBW increases with the increase of air pollution exposure during the whole pregnancy. Our meta-analysis found that birth weight decreases with NO2 increase (pooled beta = −13.63, 95% confidence interval (CI) (−28.03, 0.77)) and the risk of PTB increase for 10 µg/m3 increase in NO2 (pooled odds ratio (OR) = 1.07, 95% CI (0.90, 1.28)). However, the results were not statistically significant. Our finding supports the main international results, suggesting that increased air pollution exposure during pregnancy might contribute to adverse birth outcomes, especially LBW. This analysis of limitations of the current body of research could be used as a baseline for further studies and may serve as basis for reflection for research agenda improvements.

Unprecedented and ancient spatial data for assessing the effect of past changes on current floristic biodiversity

Quentin Poterek[1], Dominique Schwartz[1], Germain Forestier[2] and Pierre-Alexis Herrault[1]

[1] LIVE, CNRS UMR 7362, University of Strasbourg, 67083 Strasbourg, France

[2] IRIMAS, University of Haute-Alsace, 68093 Mulhouse, France

quentin.poterek@live-cnrs.unistra.fr

Landscape analysis over extensive spatial and temporal scales is crucial for monitoring changes and their impact on current biodiversity. In that respect, ancient aerial photographs establish themselves as valuable data for modeling past states of the environment. However, these photographs usually lack spectral information, do not meet current quality standards due to irregular photographic and processing techniques, and suffer from various deterioration. Thus, they hardly qualify for the computation of robust environmental variables, especially in a temporal setting where even mild variation in data quality may lead to completely erroneous results. This thesis proposes a proof-of concept over a 200km^2 area in Eastern France, located in Alsace. Firstly, we assessed the possibility of correcting and standardizing old aerial photographs, so as to match the properties of more current ones. To that end, machine learning techniques were employed, such as generative adversarial networks. The restored data were then used to produce land cover and environmental indices time series, allowing the reconstruction of past landscape states in the study area. Secondly, we will collect floristic data through field surveys in 60 grasslands, located in the study area. The corresponding parcels were already selected at random, considering various features, such as terrain and land cover. Finally, species-habitat models will be created in order to study the relationship between current floristic richness and the time series created previously, more specifically how landscapes and parcels temporal trajectories may affect biodiversity.

U-Net for multi-class classification using imbalanced dataset: Application on urban areas in Grand Est Region

Romain Wenger[1], Anne Puissant[1], Jonathan Weber[2], Germain Forestier[2], Lhassane Idoumghar[2]

[1]LIVE UMR 7362 CNRS, University of Strasbourg, 67000 Strasbourg, France

[2]IRIMAS UMR 7499 CRNS, University of Haute Alsace, 68100 Mulhouse, France

romain.wenger@live-cnrs.unistra.fr

Over the past ten years, in addition to the easy access to satellite imageries such as Sentinel constellation, we assist to a steadily improvement of the computing capacity of graphics cards, allowing calculations to be performed 4 to 6 times faster than on a processor. In the remote sensing domain, methods based on semantic segmentation improve classification results for many thematic applications. Database mapping land cover/use often remains, produced manually, take two to three years to be finalized over large area, and generate significant financial costs for production organizations. Moreover, if deep learning methods have been largely apply to landcover classes based on Sentinel-2 images, few works have been applied to map more than three thematic classes within the urban areas which are very complex and heterogeneous surface.

In this context, we propose to use and adapt a U-Net network that has shown its effectiveness in several semantic segmentation works whether in medical or satellite imagery, to classify five urban fabric classes: dense and sparse built-up areas, specialized built-up areas, specialized but vegetative areas and large-scale networks. Our contributions are three-fold: a) our approach is adapted to unbalanced datasets by adding some weights on the less represented classes b) we compare this deep approach to a classic machine learning method (Random Forest) and c) we integrated our developments into an automatic processing chain taking as input a configuration file, satellite imagery and ground truth as a shapefile.

The first experimental results based on Sentinel-2 imageries indicated that the proposed architectures outperformed state-of-the-art methods in terms of Overall Accuracy and per-class F1 score.

Keywords Land Use Mapping – Deep Learning – Sentinel-2 – Imbalanced Dataset

Source parameters of the Ml3.0 Strasbourg Earthquake (12th November 2019)

K. Drif[1,2], O. Lenglin´e[1], S. Lambotte[1], M. Grunberg[1], J. Kinscher[2] and J. Schmittbuhl[1]

[1]Université de Strasbourg - EOST/IPGS - équipe Sismologie - France

[2]Institut national de l'environnement industriel et des risques (INERIS) - France

kkdrif@unistra.fr

On the 12th of November 2019, a sequence of earthquakes, culminating at 13h38 (UTC) with an event of magnitude M_l = 3.0 (called herafter the M3 event), occurred just 5 km north of Strasbourg (identified and considered by the R´eNaSS as an induced event). The largest event was widely felt in the area and raises several questions about its origins, the fault structure on which it takes place and its mechanism. Here we investigate the source properties and the focal mechanisms of the largest events of this sequence.

By applying a spectral decomposition technique (Shearer & al., JGR, 2006), we can separate the source term of the M3 event from an attenuation term and a station term. We show that the source displacement spectrum can be adequately fitted by a simple spectral model from Brune, 1970 (See Figure). The inferred moment is M_o = 6 $10^{13} Nm$ equivalent to a moment magnitude M_w = 3.1. This method is only efficient in recovering the source property of the M3 event and failed for the smaller events. A spectral ratio approach (Lenglin´e & Got, GRL, 2011) is used for the other largest events ($M_l \geq$ 1.7). As all events of the sequence are located in a compact region (relative to the distances to the stations), at a common station, the recordings of two events will differ only by their respective source terms all the other contribution being similar will cancel out when computing the spectral ratio. We obtain for the M3 event a corner frequency of 5.4 Hz suggesting a rupture length of 125 m. For the 9 other events, we find that their respective corner frequencies and moment are all in agreement with a constant stress drop of around 10 MPa.

The M3 event focal mechanism was estimated from the P-wave first motion polarities. The mecha nism shows a sinistral strike slip fault with a movement towards the south of the western block and towards the north of the eastern block which is in accordance with the in situ stress measurements in the region.

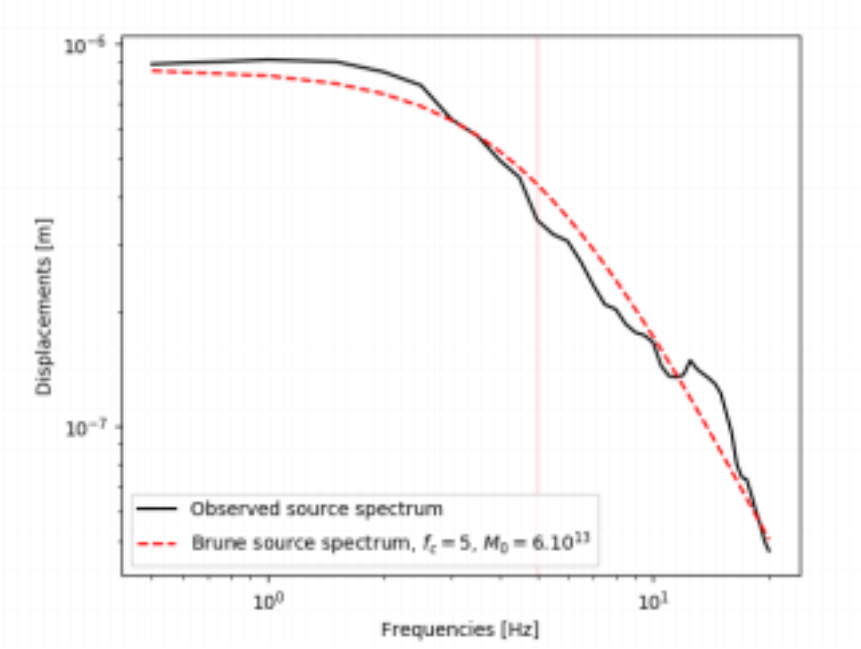


Figure 1. Source spectrum of the M3 event - Shearer decomposition. The vertical line in red represents the inferred corner frequency.

Leaching and transformation of the urban triazine biocide terbutryn: insights from Compound-Specific Isotope Analysis

Tobias Junginger, Sylvain Payraudeau, Jérémy Masbou, Gwenaël Imfeld

Institute Terre et Environnement de Strasbourg (ITES), UMR 7063, University of Strasbourg, France

tobias.junginger@etu.unistra.fr

Biocides are added in building materials like render or paints on façades as protection against algae and fungi growth. With wind driven rainfall those contaminants can leach from buildings into the environment and eventually contaminate urban groundwater. Knowledge of degradation kinetics, degradation mechanisms and the potential of urban biocides to accumulate in the environment is rare. Compound-Specific Isotope Analysis (CSIA) is an emerging approach to evaluate the extend and mechanisms of pesticide degradation in the environment. To use CSIA in field-based approaches, reference laboratory degradation experiments have to be conducted. In our study, we perform reference abiotic hydrolysis, photo-degradation and biodegradation experiments for the urban biocide terbutryn. We estimate degradation rates, follow-up the isotopic signature based on Carbon, Nitrogen and Sulphur isotopes and follow the pattern of transformation product formation. Our reference degradation experiments for terbutryn showed that CSIA can be used as concentration independent tool to identify the dominant degradation processes in the environment by taking into account (i) the isotopic enrichment of stable isotopes by dual isotope plots and (ii) the pattern of formed transformation products. Evaluated enrichment factors for carbon isotopes range from ε_C= -3.4 ‰ for abiotic hydrolysis at pH=1 to an inverse isotope effect of ε_C= 0.8 ‰ with direct photo degradation under UV irradiation, allowing to differentiate degradation mechanisms. Biodegradation rates in soil and the sediment-water interface are rather low ($t_{1/2}$ > 200 days), indicating that terbutryn may not be easily biodegraded. Our study presents lab scale experiments needed to follow micro pollutant degradation based on CSIA in the environment and show the applicability of CSIA for the urban biocide terbutryn. The gathered enrichment factors can be used to monitor contaminated field sites, support model development and trace major degradation pathways of urban biocides in the environment.

The 2018-2020 seismo-volcanic crisis, east of Mayotte, Comoros islands: in-depth study of poorly instrumented first months of the sequence

[1,2] **N. Mercury**, [1]A. Lemoine, [1]D. Bertil, [2]C. Doubre, [2]J. Van Der Woerd

[1]BRGM - French Geological Survey,

[2]UMR7516 CNRS - Institut de Physique du Globe de Strasbourg

nmercury@unistra.fr

On May 10th of 2018, a seismic sequence began 50km east of Mayotte, followed by a magnitude Mw 5.9 event on May 15th and intense underwater volcanic activity in the following months. Although Mayotte is the easternmost island of the Comoros volcanic archipelago (located in the northern Mozambique Channel, between Tanzania and Madagascar), these seismo-volcanic events were unexpected. Before February 2019 and the on- and off-shore instrumentation survey campaigns (within the framework of INSU-TELLUS, MAYOBS, REVOSIMA), the local seismic monitoring network was poor. Detection and localization of many events associated to magma migration phases at the beginning of the crisis were limited (Lemoine et al., 2020). Several stations from several international networks allowed to obtain a disposable monitoring network, before the ReVoSiMa installed better tools.

The four first months correspond to 70% of the cumulated seismic moment of the crisis, and to the formation of some recent structures, including a new 800m high submarine volcano (Feuillet et al., in revision). We ought to better define the actual known phases, well illustrated on the new catalog. A migration phase during first weeks (until June 2018, epicenters move south and east) preceded a phase of strong activity (01 to 09 June 2018) until the beginning of an unprecedented eruption (early July 2018, Lemoine et al., 2020). End of August 2018 marked the initiation of another swarm westward, still ongoing after two years (Hoste Colomer, poster AGU 2020).

The catalog of events between May and September 2018 has been completed and reprocessed. In particular, we tested new velocity models, added data from unused regional onshore stations, hence improving the quality and quantity of events and their localization. This catalog went from around 300 events to almost 1200 seismic events localized and allow to better describe the unrest phases of the four first months of this sequence.

Resolution and Uncertainties Of Tomographic Models for Quantitative Analysis: A Surface Wave Example From the Pacific.

Franck Latallerie[1], Alessia Maggi[1], Christophe Zaroli[1] et Sophie Lambotte[1]

[1]Institut de Physique du Globe de Strasbourg, UMR7516, Université de Strasbourg, EOST/CNRS, 67000 Strasbourg France

flatallerie@unistra.fr

Seismic tomography is a key tool to estimate physical parameters within the Earth interior. However seismological data suffer from highly heterogeneous spatial distribution and from significant noise. As a consequence, tomographic models are uncertain distorded images of the reality. This study aims to better assess the reliability of velocity anomalies observed with seismic tomography in the Pacific upper mantle.

To assess if there are trustworthy velocity anomalies in the Pacific upper mantle, we use the recently developped SOLA Backus Gilbert linear inversion scheme. It is based directly on the model resolution and uncertainty and provides all at once the tomographic model with its resolution and uncertainty. We apply this inversion scheme in the Pacific ocean using path averaged Rayleigh-wave velocity profiles. After building a range of models for various resolution uncertainty trade-offs, we analyze our preferred model using its resolution and uncertainty. We discuss whether, in addition to longer-scales velocity features associated with the thermal cooling of the Pacific lithosphere, the model also shows reliable evidence of short-scale velocity features. In particular, we examine a slow velocity anomaly located north-east of Hawaii, at about 200 km depth, and a pattern of alternatively slow and fast velocity bands, aligned approximately north west to south-east, between 200 and 400 km depth; according to our resolution and uncertainty analyses, both these features seem to be resolved.

Future directions include to search for more accurate estimates of the data uncertainties to be really confident in the model uncertainties. In addition, a finite frequency description of surface waves may help to linearize the tomographic problem and to avoid coupling the SOLA Backus Gilbert linear inversion scheme with another non-linear inversion. With these new developments and new data, tomography may give new robust answers about the Earth interior.

Parametezization of hydrogeological models using geophysical methods

Moua Rohianuu[1], Girard Jean-François[1] , Lesparre Nolwenn[2] , Belfort Benjamin[2]

[1] Institut de Physique du Globe de Strasbourg, Strasbourg, France

[2] Laboratoire d'HYdrologie et de GEochimie de Strasbourg, Strasbourg, France

rmoua@unistra.fr

Soil water content variation experiments were conducted in both controlled and natural field. Monitoring measurements were applied using in situ sensors and geophysical methods, namely ground penetrating radar (GPR) and magnetic resonance sounding.

Hydrogeological models of these experiments are created and we have developed the first tools to characterize hydrodynamic parameters of such models. The inversion algorithm developed to fit the hydrodynamic parameters of reference GPR data is being tested.

Preliminary tests of the inversion algorithm were carried out focusing on homogeneous soil infiltration hydrological models, described by Mualem-van Genuchten (M-vG) retention parameters. Our first analyses were focused on the sensibility against hydrodynamic parameters, of the GPR waves two-way travel time when reflected by the water infiltration front.

Results have shown that looking after this proxy, the optimization would be highly sensitive to the saturated hydraulic conductivity K_{sat} but not to the M-vG parameters.

Being able to fit the K_{sat} of a hydrogeological model would be a strong performance, we are still trying different approaches to estimate the M-vG parameters. We are currently analyzing the sensitivity of the GPR waves two-way travel time when reflected by a reflector located under the water table level.

Long and short time evolution of deep seated gravitational slope deformation : contribution to knowledge of phenomena for the management of alea in the Alpine mountains

C. Boivin [a], J.P. Malet [a], C. Bertrand [b], F. Chabaux [c], J. van der Woerd [a], Y. Thiery [d], F. Lacquement [d], D. Amitrano [f]

[a] *Institut de Physique du Globe de Strasbourg – IPGS/DA - UMR 7516 CNRS-Unistra*
[b] *Laboratoire Chrono-Environnement – LCE / UMR 6249 CNRS – UFC*
[c] *Laboratoire d'Hydrologie et de Géochimie de Strasbourg – BISE / UMR 7517 – Unistra* [d] *Bureau de Recherches Géologiques et Minières – BRGM*
[f] *Institut des sciences de la Terre – ISTerre – UMR 5275*

c.boivin@unistra.fr

The **Deep Seated Gravitational Slope Deformation (DSGSD)** are defined according to the study by *Agliardi and al., 2001, 2009* and the study by *Panek and Klimes., 2016* as being a set of rock mass characterized by a generally slow movement and which can affect all the slopes of a valley or a mountain range. The study of DSGSD start in the 1940s (*Agliardi 2000*) and this deep instability is identified in many mountains (ex: Alps, Alaska, Rocky Mountains, Andes, Pyrenees, Japan, New Zeeland…). This geological object are present only in slope topography but it can affect both isolated low relief and very high mountain ranges (*Panek and Klimes., 2016*). Mostly, this deep instability are identified in many case like the origin zone for important landslide like the example of La Clapière landslide in the Alpes Maritimes (*Bigot Cormier et al., 2005*) or Beauregard landslide in Aosta Valley in Italia (*Barla et al., 2010*). The DSGSD represent an important object we must understand to anticipate catastrophic landslides.

Actually, many factors that could be at the origin or controlling the evolution of DSGSD have been identified such as for example the structural heritage, the climate or the tectonic activity (*Agliardi 2000; 2009; 2013*; *Jomard 2006*; *Sanchez et al., 2009*; *Zorzi et al., 2013*; *Panek and Klimes., 2016; Ostermann and Sanders., 2017; Blondeau 2018*). However, their respective roles in the evolution of deep gravity instabilities are still debated. The long-term and short term evolution of DSGSD is still poorly understood but represents an important point to characterize in order to predict future major landslides. A first inventory of DSGSD began to be carried out by certain studies such as *Blondeau 2018* or *Crosta et al 2013* in the Alps. These same studies have also started to prioritize the factors controlling the evolution of DSGSD.

It is in order to better understand the short-term (<100 years) and long-term (> 100 years) evolution of the DSGSD of the French Alpine massifs and the link with the occurrence of landslides, that this thesis project is developed. The main objective of this project, will be proposed models of the evolution of DSGSD since the last glaciations. But also to propose key interpretations of the future evolution of these objects in order to locate the areas likely to initiate landslides. To carry out this project, two study areas in the French Alpine massifs were chosen: Beaufortain and Queyras. These areas were selected because they represent areas of referencing and localization gaps in DSGSD. In addition, they have the advantage of having a low lithological diversity making it possible to simplify the identification of the factors influencing the evolution of DSGSD. To achieve these objectives, a geomorphological analysis on satellite data as well as on the ground is carried out to locate and identify the surface structures of the DSGSD. Several dating (^{14}C, ^{10}Be or ^{36}Cl) will be carried out in order to reconstruct the history of these objects and understand the factors that controlled their evolution.