

Laboratory of Soil Mechanics

Chair “Gaz Naturel” Petrosvibri

Prof. Lyesse Laloui

ANNUAL REPORT
2018

ABOUT US

Besides advanced geomechanical research activities, our research group gives priority to the protection of the environment, landforms and structures from geo-hazards and industrial damage. Our experimental and modelling resources are mobilised to understand, investigate and predict the environmental impact of the new technologies such as nuclear waste disposal, and to provide tools for the up-to-date design of the geo-structures. In addition, in the context of the Chair “Gaz Naturel” Petrosvibri, we focus our activities on geo-engineering and CO2 storage. Our scientific and technological developments are permanently transferred to education and industry.

OUR GREATEST RESOURCE IS THE TEAM

PREAMBLE

PROF. LYESSE LALOU

This year my group once again showed substantial growth, contributing to fundamental and applied research activities on near-surface geothermal energy systems, nuclear waste storage, bio-improved soils, landslide analysis, shale gas behaviour and claimed a key role in the field of geoengineering of CO2 storage. We succeeded in the transfer of the technology elaborated in the lab with two spin offs, Medusoil and GeoEg, founded by the members of LMS as well as the launching, with China, of the new international technology cooperation platform “International Joint Research Center for Energy Geotechnics”.

Following ten years of research in the field of soil bio improvement, this year I was very honoured to start my new project BIOGEOS, founded by the ERC

Advanced Grant. The year was also very fruitful for the personal development of our members. Alessandro Rotta Loria is opening a new chapter in his professional career, accepting the prestigious position of Tenure Track Assistant Professor at Northwestern University. The work of one of our post-docs – Dimitrios Terzis was supported by an important EPFL Innogrant, which allows him to cooperate with key Swiss industrial associates. I would like to acknowledge my collaborators for their hard work and enthusiasm. We are a group of really exceptional people. I am grateful to be able to cooperate with them.

The year 2018 was marked by the the International Symposium on Energy Geotechnics. During this four day event, we hosted 250 participants from 35 countries in Lausanne.

Let the further pages of this report speak for themselves. With a head full of new ideas, we look forward to the next year filled with new challenges and opportunities.

The Laboratory of Soil Mechanics (LMS) is one of the laboratories within the School of Architecture, Civil and Environmental Engineering of the Swiss Federal Institute of Technology, Lausanne (EPFL). Since its establishment, as the successor of Geotechnical Laboratory founded in 1935, the LMS has been contributing to fundamental and applied research activities, education, as well as civil engineering constructin works.





Dimitrios Terzis giving a presentation during Symposium on Energy Geotechnics



LMS Laboratory visit during SEG guided by Eleonora Crisci



Bio-improved soil sample

THE YEAR

2018 AT LMS

18.01

ROBERVAL PRIZE

THE AWARD

The Roberval Prize is an international competition for the promotion and distribution of science and technology in the French language.



11.04

PROF. LALOU AWARDED PRESTIGIOUS ERC ADVANCED GRANT

THE AWARD

The ERC Advanced Grants are awarded to established, leading principal investigators who have a track-record of significant research achievements in the last 10 years.



24.05.

PROF. LALOU REWARDED BY BCV FOUNDATION

THE AWARD

BCV Foundation, annually awards 3 or 4 major personalities in the scientific, social, cultural or charitable fields. This year prof. Laloui was honored with their award.



28.05

ENERGY GEOTECHNICS BOOK PUBLISHED PUBLICATION

Energy Geotechnics is the book of proceedings which contains all the full papers accepted to SEG 2018 and has been published and now on Scopus .



25-28.09

INTERNATIONAL SYMPOSIUM ON ENERGY GEOTECHNICS CONFERENCE

CONFERENCE

SEG has been organized recognizing the strong need for shared knowledge in innovative and challenging applications on energy geotechnics on Energy Geotechnics.



15.10

WORLD'S LARGEST FIELD GROUND BIO-STABILIZATION

TECH TRANSFER

In October this year 300 m³ of bio-stabilized ground has been delivered.



ROBERVAL PRIZE

The book “Mécanique des sols et des roches” written by EPFL professors: **Laurent Vulliet**, **Lyesse Laloui** and **Jian Zhao** (now at the University Monash in Australia), published in 2016 was awarded the Roberval Prize.

The prize was given by the president of the French Academy of Sciences in the prestigious setting of the National Institute of France in Paris, in the presence of 150 guests.

find out more on page: 24

BCV'S FOUNDATION REWARD

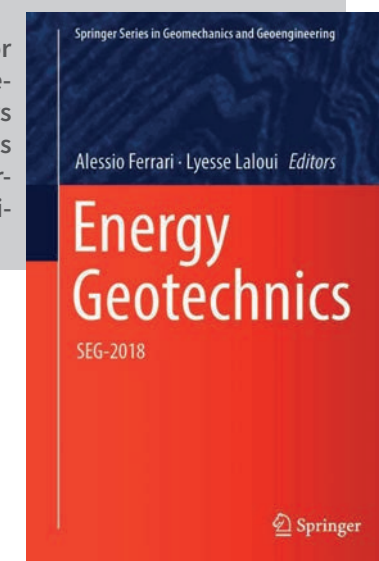
BCV Foundation annually awards 3 or 4 major personalities in the scientific, social, cultural or charitable fields. The prize granted to Prof. Laloui will benefit the promotion of energy geostructure technology.

find out more on page: 25

ENERGY GEOTECHNICS

This book collects selected full papers presented at the International Symposium on Energy Geotechnics 2018 (SEG-2018), held on September 25th – 28th, 2018, in Lausanne (EPFL).

The book is intended for postgraduate students, researchers and practitioners working on geomechanics and geotechnical engineering for energy-related applications.



ERC ADVANCED GRANT

The research work of Professor Lyesse Laloui focuses on the mechanics and advanced microstructural inspection of porous geo-materials in interaction with hydraulic, bio-chemical and thermal phenomena. In his new ERC project entitled BIOGEOS “BIO-mediated GEO-material Strengthening for engineering applications”, Lyesse Laloui foresees to push the boundaries of understanding around nature-based and bio-inspired, sustainable solutions for consolidating and strengthening Earth materials for construction and subterranean applications.

find out more on page: 26

SEG CONFERENCE

SEG-2018 aims to serve as a forum for promoting the exchange of ideas, practices and state-of-the-art on a broad range of topics in the area.

Keynote lectures from the most prominent researchers and practitioners in the field, state-of-the-art lectures and technical sessions focusing on the task forces of TC-308 and discussion sessions for compiling the contributions of the day were a part of SEG-2018.

find out more on page: 16

THE LARGEST IN THE WORLD FIELD APPLICATION OF BIO-IMPROVEMENT

Bio-mediated calcite precipitation in soils is not a new concept. It has occurred in natural environments for millions of years and its core elements have been known to scientists for decades. However, little is done towards mastering this core technology at real-world scale and even less towards building mainstream engineering solutions out of it. To this purpose, BIOGEOS mobilizes multidisciplinary and applicable research and a global vision of how geo-engineering practice can evolve towards a sustainable future.

find out more on page: 26

MAIN ACTIVITIES



RESEARCH

LMS
MAIN IDEAS



sustainability
environmental friendliness
coupled characterisation
of geomaterials
integrated approach

1

ENERGY GEOSTRUCTURES

The basis of our work consists of observing, measuring, understanding and predicting how energy geostructures behave from a multiphysical perspective. Special attention is put on cyclic thermo-mechanical behavior as well as heat extraction in crystalline rocks at high depths. The work is targeted to develop practical tools for design and conception.



2

SOIL BIOIMPROVEMENT

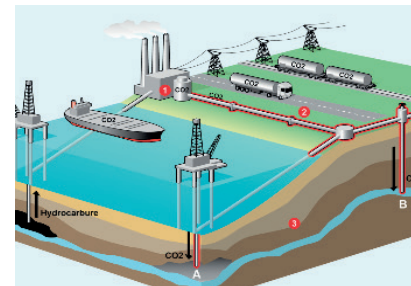
We investigate a novel soil improvement strategy, inspired by the natural process of biologically driven crystal mineralization. The research aims to develop the conception of a geo-mechanical model to describe the enhanced behavior of the bio-treated soil, optimize the improvement process and enhance the practical applicability of this technique. The works are carried out from laboratory to field scales.



3

CO2 STORAGE

CO2 sequestration in deep geological formations is one of most suitable solutions for CCS (Carbon Capture and Storage). The interplay between transport, reaction and mechanics is tackled through innovative interdisciplinary research both experimentally and numerically. Our research focuses on experimental investigation of the behaviour of shale caprocks as well as on the quantitative risk prediction of large earthquakes occurring in the basement rocks below fluid injection intervals.



4

SHALE GAS EXTRACTION

Shales are extremely complex geomaterials and many challenges are associated with the extraction of shale gas. Geomechanics is the key to achieving a better understanding and a deeper knowledge of a shale's behaviour when subjected to engineering practices. Our laboratory and numerical work is targeted to develop practical tools aiding in better productivities, larger flowback percentages, and a general better understanding of the shale gas reservoirs.



5

NUCLEAR WASTE STORAGE

Disposal in deep clay geological formations is the most promising way to dispose of high level wastes. The laboratory works as well as numerical modelling are being conducted taking into account complex thermo-hydro-mechanical (THM) behaviour of materials. Involved materials are deeply analyzed in order to provide reliable predictions for the behaviour of storage facilities.

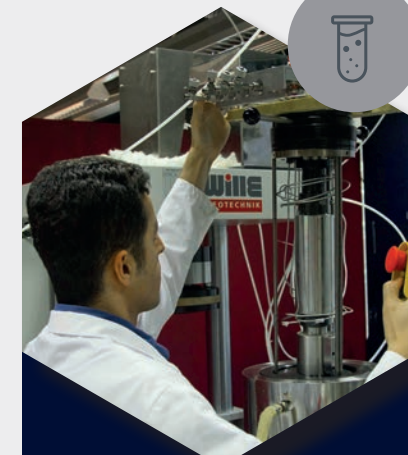


CONSULTING & EXPERTISE



ADVANCED CONSULTING

- **NUMERICAL MODELING** (finite elements, thermo-hydro-mechanical couplings)
- **COMPUTATION** of geotechnical structures
- Judicial or private **EXPERT EVALUATIONS**

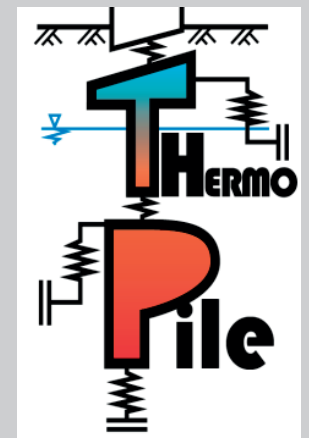


LAB

- **CONVENTIONAL TESTING**
- **ADVANCED GEOTECHNICAL TESTING**
 - Triaxial and oedometric tests on unsaturated geomaterials
 - Non-isothermal testing of soils and soil-concrete interfaces
 - Dynamic triaxial testing with articulated stress paths
 - Gas and water permeability in unsaturated conditions
- **DEEP GEO-ENGINEERING**
 - High-pressure and high-temperature triaxial and oedometric tests.
 - Simultaneous Independent control of different pore fluid pressures including CO2
 - Multiphysical testing of shales and gas shale applications



SOFTWARE



TECH TRANSFER

START UPS LAUNCHED AT LMS

MEDUSOIL

Medusoil is an EPFL spin-off and applies world's first ground bio-reinforcement technology to mainstream construction problems. By coupling traditional construction practice with lab-developed, nature-based biochemical carriers we reduce application costs, minimize equipment requirements and increase long-term ground resistance against failures and environmental threats.



EROSION PROTECTION



MeduSoil is among 692 spin-off companies (as of August 2018) created within the ETH domain which comprises Switzerland's leading Federal Technology Institutions. MeduSoil offers fast, easy-to-implement and eco-friendly ground stabilization that lasts.

MeduSoil LLC is co-founded by Dr. Dimitrios Terzis along with his former PhD advisor Prof. Lyesse Laloui.



The spin-off develops and commercializes a ground stabilization agent which produces mineral calcite in the subsurface when mixed with the ground. Currently, MeduSoil is involved in custom infrastructure repair works and new construction projects.

GEOEG

GEOEG is an EPFL spin-off that provides integrated solutions to apply a revolutionary technology for urban environments: energy geostructures. Energy geostructures are a breakthrough, integrated technology that can be used for providing renewable energy and structural support to any type of built environment, by coupling the structural support role of the geostructures with the heating-cooling role of the geothermal heat exchangers. At GEOEG we strive to sustain human activity with a limited impact on the environment.



ENERGY SUPPLY & STRUCTURAL SUPPORT



The activities carried out at GEOEG are the results of more than 20 years of research and development at the EPFL in the scopes of geoenergy, mechanics, geotechnical engineering, structural engineering, energy engineering and building physics.

Geogeg Sàrl is a spin-off co-founded by Prof. Alessandro Rotta Loria along with his former Ph.D. advisor Prof. Lyesse Laloui



GEOEG currently offers six services devoted to the application of energy geostructures: consulting, analysis, design, testing, monitoring and training. These services have been currently proposed for several architectural and engineering projects around the world.



Current investment opportunities: MeduSoil is seeking a seed investment to support its growing activities and path to international markets.



Patent application: Coupled use of the stabilization agent with geo-synthetics.



MeduSoil received in 2018 critical financial support from VentureKICK and Climate-KIC to support its growth and market entry.



Heating & cooling



Hot water production



De-icing



Underground thermal energy storage



INTERNATIONAL ACTIVITY OF LMS

EU - BEACON PROJECT

25 EUROPEAN INSTITUTIONS FROM 10 COUNTRIES

The overall objective of the Beacon project is to develop and test the tools necessary for the assessment of the mechanical evolution of an installed bentonite barrier and the resulting sealing ability of the barrier in all geological repository concepts



EU - TERRE PROJECT

14 EUROPEAN PARTNERS FROM 11 COUNTRIES

TERRE aims to promote, through the PhD projects of the Early Stage Research Fellows, a new vision for Civil Engineering training and education. This vision goes beyond a mechanistic view of geotechnical behaviour of the ground and takes a nature-centric scientific approach.



CHICAGO, USA 18 SEPTEMBER 2018 KEYNOTE LECTURE

Professor Lyesse Laloui delivered two lectures at Energy Foundations Seminar organized by Deep Foundations Institute. The one-day event focused on Practical Construction Aspects of Designing, Installing and Operating a Ground-Sourced Heat Pump Solution Connected to Energy Foundations. Invited speakers detailed good practice guidelines and discussed the importance and benefits of long-term management and operation of ground-sourced heat pump solution.

Professor Laloui contributed to the session STATE-OF-PRACTICE IN ENERGY FOUNDATION TECHNOLOGIES discussing Current Research Conclusions on Energy Foundations as well as in INNOVATIVE AND CHALLENGING APPLICATIONS talking about Energy Tunnels and Slurry Wall.

QUERÉTARO, MEXICO OCTOBER 2018 KEYNOTE LECTURE

During International Symposium of Unsaturated Soils, Dr. Alessio Ferrari delivered a Keynote Lecture entitled "Hydro-Mechanical analyses of volcanic slopes." The objective of the Symposium was to discuss the advances in the field of unsaturated soil mechanics in order to enrich the study of Geotechnics.

EU - GREAT PROJECT

17 PARTNERS FROM 11 COUNTRIES

Geotechnical and geological Responses to climate change: Exchanging Approaches and Technologies on a world-wide scale. The GREAT focuses on the geotechnical and geological responses to the global challenge of climate change stimulating long-term collaboration between European and BRICS institutions via the secondment of staff members.



PORTUGAL

INTERNATIONAL EVALUATION PANEL

Professor Lyesse Laloui has been invited to chair the international evaluation panel which addresses the six main Civil and Geological Engineering Departments in Portugal. Fundação para a Ciência e a Tecnologia (FCT) is the Portuguese public agency that supports science, technology and innovation, in all scientific domains, under the responsibility of the Ministry for Science, Technology and Higher Education. The panel of evaluators is composed of researchers from all around the world, since all of them have to be working outside Portugal.

LAUSANNE, SWITZERLAND

26 SEPTEMBER 2018

KEYNOTE LECTURE

During the Symposium on Energy Geotechnics organized by our group, professor Laloui was not only present as the head of the organising committee, but he also delivered a Keynote Lecture. The lecture's title was "Analysis, Design And Application Of Energy Geostructures From The Building To The City Scale"

HOHAI UNIVERSITY, CHINA INTERNATIONAL JOINT RESEARCH CENTER

Prof. Lyesse Laloui is co-founder of the International Joint Research Center for Energy Geotechnics in China, a new international technology cooperation platform built by GeoHohai of Hohai University, headed by Prof. Kong Gangqiang, and the Laboratory of Soil Mechanics at EPFL. The Research Center is also associated with leading Chinese companies from the broad field of the construction industry. The Energy Geotechnical Center actively contributes to the research and application of energy geostructures. It focuses on the development and industrialization of this breakthrough technology that combines the underground infrastructure growth with exploitation of the shallow geothermal energy. IJRC leverages interdisciplinary knowledge in order to integrate intelligent constructions and new energy challenges. This new cooperation fosters to build an energy geotechnical research platform that influences China significantly and will have a further impact on other countries along the "Belt and Road".

ASSISI, ITALY MAY 2018 KEYNOTE LECTURE

Professor Lyesse Laloui delivered a keynote lecture on the THMC behaviour of shales at the Fourth International Symposium on Computational Geomechanics (ComGeo IV). The ComGeo series of Symposia is a multi-disciplinary international forum characterized by a limited number of participants and a high technical standard.

DR. IRENA HANUSOVÁ
Czech Radioactive Waste Repository Authority

PROF. TOMASZ HUECKEL
Duke University

PROF. SALAH SADEK
American University of Beirut

PROF. JINHYUN CHOO
University of Hong Kong

PROF. KONG GANGQIANG
Hohai University

PROF. MARIO MANASSERO
Politecnico di Torino

PROF. PAOLO SIMONINI
University of Padova

VISITING EXPERTS

Saeed Tourchi
Polytechnic University of Catalonia

Saina Khoshbakht
Amirkabir University of Technology

Saeed Kouzegaran
Teheran University of Science and Technology

Zhen Weng - Hohai University

VISITING PHDS

VISITING STUDENTS

Mattia Dall'Acqua
University of Trento

Francesco di Bari
Politecnico di Torino

Andrea Caldirola
Politecnico di Torino

Caroline Girard
Polytech Sorbonne

EDUCATION

MASTER PROJECTS



GRÉGOIRE AGUETTANT

Washboard effect of unpaved roads



MARGAUX PELTIER

Evaluation du potentiel thermique de la ligne de métro m3 de Lausanne



BENOÎT COUSIN

Feasibility and energy performance of an energy segmental lining for a subway tunnel



STEFANO CINGARI

Étude de faisabilité de l'utilisation de la géothermie dans les gares de métro: Application au Grand Paris Express



AYMEN ACHICH

Numerical simulation of deck de-icing using energy pile systems



NICOLAS DELESSERT

Étude géotechnique et géothermique d'une tranchée couverte en site urbain



NICOLA SCHMID

Etude géotechnique des ouvrages souterrains de l'extension de l'aménagement hydroélectrique de Lavey



ARABELLE DE SAUSSURE

A comparison of induced seismic events caused by hydraulic fracturing in engineered geothermal systems (EGS) and shale reservoir exploitation.



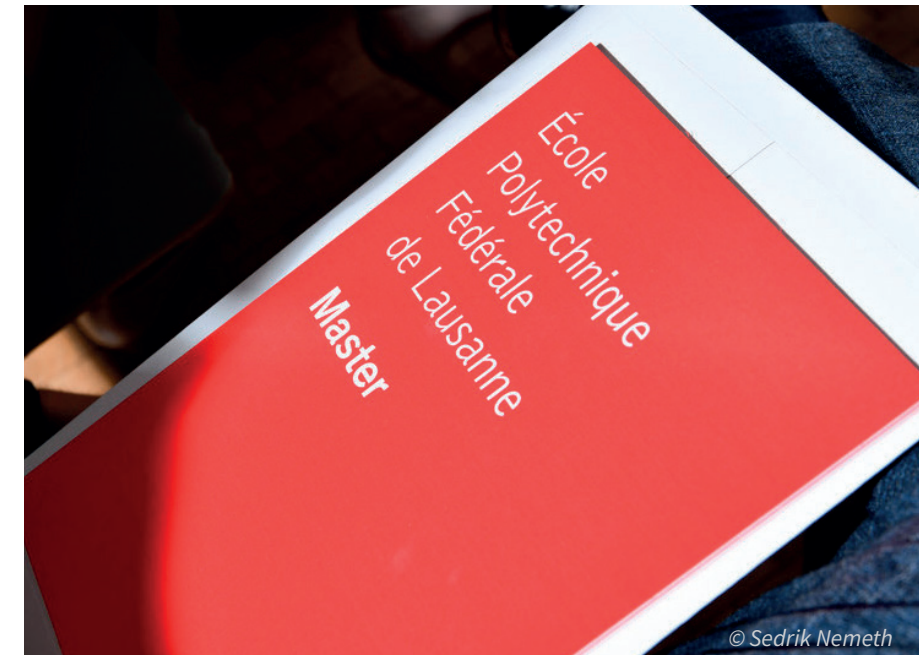
RAY HARRAN

*Decision Aids For Tunneling
A Catalogue For Application To Small Tunnels*

Photos © Sedrik Nemeth

In 2018 nine students completed their Master theses under the supervision of Prof. Laloui and four of them (Margaux, Benoît, Stefano and Ray) are now working at the Laboratory of Soil Mechanics.

The official graduation day-Magistrale 2018 took place on the 6th of October in the Swiss Tech Convention center.



E V E N T S



SYMPOSIUM ON ENERGY GEOTECHNICS

SEG INTERNATIONAL CONFERENCE

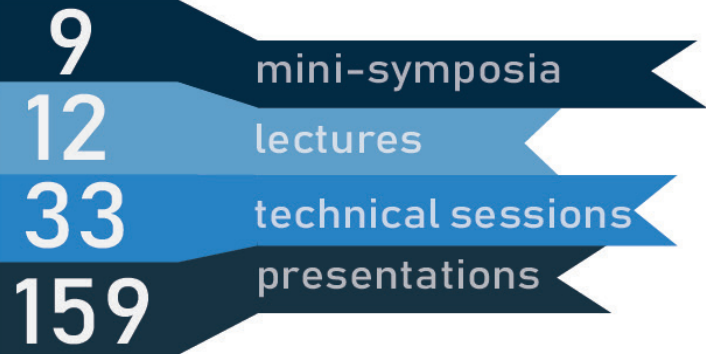
The International Symposium on Energy Geotechnics (SEG) 2018 was organized recognizing the strong need for shared knowledge in innovative and challenging applications on energy geotechnics. SEG-2018 aimed to serve as a forum for promoting the exchange of ideas, practices and state-of-the-art on a broad range of topics in the area.

Keynote lectures from the most prominent researchers and practitioners in the field, state-of-the-art lectures and technical sessions focusing on the task forces of TC-308 and discussion sessions for compiling the contributions of the day were a part of SEG-2018.



September
25th-28th,
2018

SEG IN NUMBERS



- RESEARCH FIELDS
- ✓ Carbon Sequestration
 - ✓ Energy Geo-Storage & Geo-structures
 - ✓ Urban Planning for Energy Geo-Systems
 - ✓ Gas Hydrate Sediments
 - ✓ Unconventional Reservoirs
 - ✓ Foundations for Floating Offshore Structures
 - ✓ Shallow & Deep Subsurface Geo-Thermal Systems
 - ✓ Natural & Hydraulic Fractured Reservoirs
 - ✓ Geotechnical Challenges of Energy Infra-Structures
 - ✓ THMC Behavior of Geomaterials
 - ✓ Nuclear Waste Deposits

INNOVATION HUB



During SEG-2018 an “Innovation Hub” was launched featuring an exposition area and a special interactive session dedicated to supporting and promoting the community of inventors and entrepreneurs, active in the greater field of energy geotechnics.

The hub aimed to offer a common platform for showcasing innovative technologies to the members of our community and to the wider geo-engineering, geo-science and geotechnics industries. Equipment manufacturers and service providers were invited to demonstrate their expertise and share case stories on how their products and services impact our field and challenge the established practice and execution procedures, as well as quality control, risk prevention, environmental and safety compliances.

ACTIVITIES DURING THE CONFERENCE

The participants of SEG 2018 had the chance to participate in many lectures, symposiums and technical sessions but also they were able to visit the laboratory at of the LMS and Mont Terri laboratory, located in the canton of Jura, 300 m underground. Numerous experiments are carried out here on the Opalinus Clay, which is, among other things, a potential host rock for future nuclear waste storage activities in Switzerland.





CHAIRMEN

Prof. **Lyesse Laloui**
 Prof. **Alessio Ferrari**
 Swiss Federal Institute
 of Technology, EPFL
 Lausanne

PUBLICATIONS

Full papers were
 included in the
 proceedings of the
 symposium published
 by Springer and indexed
 in Scopus and Springer-
 Link

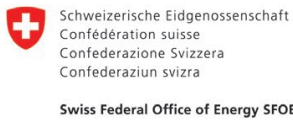
LOCATION

Swiss Tech Convention
 Center at Swiss Federal
 Institute of Technology in
 Lausanne (EPFL)



OUR PARTNERS AND SPONSORS

Principal sponsor



Gala dinner sponsor



Silver sponsors



Sponsors



Partners



ORGANIZING COMMITTEE



Prof. Lyesse
 Laloui



Dr. Alessio Ferrari



Dr. Melis Sutman



Barnaby Fryer



Dr. Patrycja
 Baryla



Gianluca
 Speranza



Dr. Aldo
 Madaschi



Dr. Dimitrios
 Terzis



Dr. Patrick
 Hicher

Elena



WE DID IT!

From left: Etienne, Patrycja, Gianluca



Professor's Laloui lecture



From left: Cristiano Jose, Melis



Gala Dinner - from top left: Dr. J. Desroches, Prof. A. Gens, Prof. C. Santamarina, Wife of Prof. Santamarina, Prof. Tae-Sup Yun, Prof. L. Laloui, Prof. T. Hueckel, Prof. A. Ferrari, Dr. Gunter Siddiqi, Dr. J. Rutqvist.



ENERGY GEOSTRUCTURES

SHORT COURSE FOR PRACTITIONERS

The short course for practitioners and academics organized by prof. Lyesse Laloui and dr. Alessandro F. Rotta Loria took place in the EPFL campus on 20-22 march 2018. The lectures also featured the presence of worldwide renown experts in the field such as dr. **Tony Amis** (Gi Energy) and dr. **Sebastian Homuth** (Zueblin).



**March
20th-22nd,
2018**



**March
6th-8th,
2019**



23 PARTICIPANTS
FROM **8** COUNTRIES

Organized by
Prof. Lyesse
Laloui
and Dr.
Alessandro
Rotta Loria



DAY 1

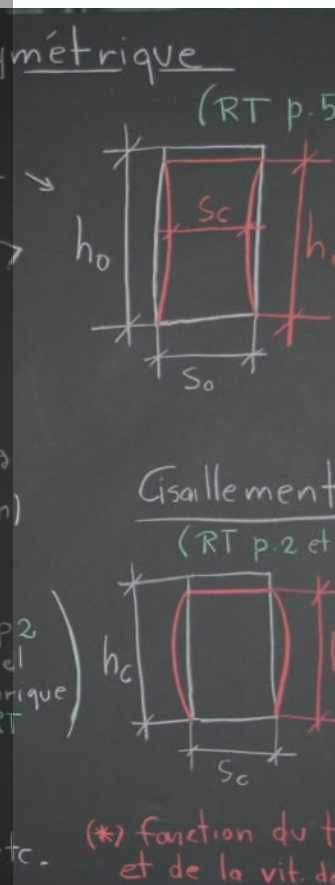
The first day had been dedicated to the energy behaviour of such geostructures, discussing the theoretical aspects governing the thermal exchange processes. Exercise sessions about the energy design of energy geostructures were included.

DAY 2

The second day encompassed topics related to the thermo-mechanical analysis of energy piles, walls, tunnels and anchors. Dedicated exercise sessions were included. A visit of the LMS experimental facilities closed the day.

DAY 3

The third and last day featured the presence of worldwide renown experts in the field of energy geostructures which shared their experience about real project developments. A final lecture and exercise session related to the performance-based design of energy geostructures in the framework of Eurocodes gave a final contribution to this course.



THE GOAL OF THE COURSE IS TO PROVIDE THE PARTICIPANTS WITH A DEEP UNDERSTANDING ON TOPICS IN **GEOMECHANICS** WHICH ARE FUNDAMENTAL FOR APPLICATIONS RELATED TO **ENERGY** AND THE **ENVIRONMENT**

WORKSHOP GEO-ENERGIES

IN THE CONTEXT OF THE GEO-ENERGIES OF THE SCCER-SOE

The one day workshop was organized in the context of the Swiss Competence Center for Energy Research – Supply of Electricity (SCCER-SoE), by Prof. Lyesse Laloui, leader of the Geo-energies working package (WP1), and Dr. Alberto Minardi. It aimed at gathering PhD and post-doc researchers active in the field of geo-energies to discuss current and future challenges in the framework of the Swiss Energy Strategy 2050. The SCCER-SoE is financed by the Swiss National Science Foundation (SNSF) and the Swiss Innovation Agency Innosuisse.



**June 5th,
2018**

Organized by
Prof. Lyesse
Laloui and
Dr. Alberto
Minardi



15 SCIENTIFIC
PRESENTATIONS
WERE DELIVERED

35 RESEARCHERS FROM THE
DIFFERENT UNIVERSITIES INVOLVED
IN THE SCCER-SOE CONSORTIUM
ATTENDED TO THE WORKSHOP

TOPICS:

- ☒ caprock characterization CO2 geological storage
- ☒ deep geothermal energy and hydraulic stimulation
- ☒ fracture mechanics and fracture characterization
- ☒ induced seismicity and in-situ stress determination



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

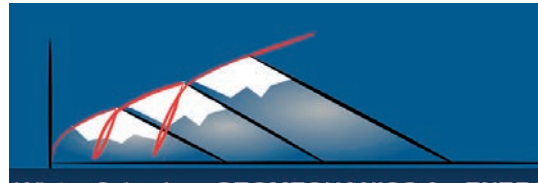
Swiss Federal Office of Energy SFOE



GETE WINTER SCHOOL

WINTER SCHOOL ON GEOMECHANICS FOR ENERGY AND THE ENVIRONMENT

In January 2018 the first edition of the GETE Winter School in **Villars-sur-Ollon**, in the **heart of the Swiss Alps** was held.



January
23rd-25th
2018



January
22nd-24th
2019

ALSO NEXT
YEAR!

Organized by
Prof. Lyesse
Laloui and Dr.
Alessio Ferrari
and Angelica
Tuttolomondo



Lectures were given by internationally renowned experts:

- Tomasz Hueckel** (Duke University)
Chemical effects in mechanical behaviour of geo-structures
- Ronaldo I. Borja** (Stanford University)
Computational poromechanics
- Emmanuel Detournay** (University of Minnesota)
Mechanics of Hydraulic Fractures
- Alessio Ferrari** (EPF Lausanne)
Advanced Thermo-Hydro-Mechanical laboratory testing
- Lyesse Laloui** (EPF Lausanne)
Multiphysical constitutive framework for soils and shales
- Brice Lecampion** (EPF Lausanne)
Mechanics of Hydraulic Fractures

PARTICIPATION STATISTICS

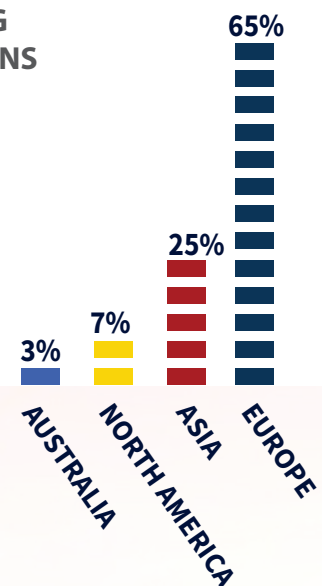


40 PARTICIPANTS
FROM **7** COUNTRIES

3 AD-HOC
BRAINSTORMING
EVENING SESSIONS

6 EXTENSIVE
LECTURES

3 DAY SCHOOL



THE SCHOOL IS ORGANIZED IN THE FRAMEWORK OF THE “INTERNATIONAL JOURNAL GEOMECHANICS FOR THE ENERGY AND THE ENVIRONMENT”. MORNING LECTURES AND EVENING BRAINSTORMING SESSIONS ARE SEPARATED BY SKIING ACTIVITIES.

ACHIEVEMENTS

ROBERVAL PRIZE

GRANTING THE BEST WORKS EXPLAINING TECHNOLOGY WRITTEN IN FRENCH

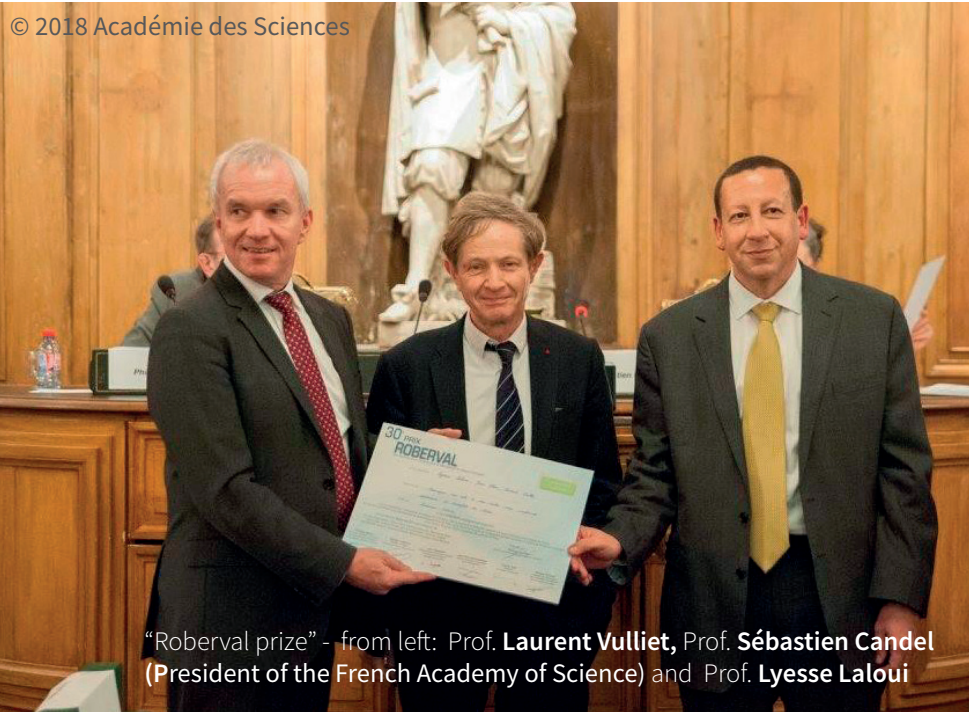
The prize was given by the president of the French Academy of Sciences in the prestigious setting of the National Institute of France in Paris, in the presence of 150 guests.

This year the work entitled “**Mécanique des sols et des roches**” was awarded. The book is a result of work of three professors of the EPFL: **Laurent Vulliet**, **Lyesse Laloui** and **Jian Zhao** (now at the University Monash in Australia), published by “ Presses polytechniques et universitaires romandes “

The Roberval Prize is an international competition for the promotion and distribution of science and technology in the French language.

Soil mechanics and rock mechanics are disciplines generally treated separately in the literature. For the first time, a book combines these two specialties, integrating also the knowledge of subsurface flows and thermal transfers.

Specifically designed in a spirit of engineering, this unprecedented publication refers in an international perspective to the most recent standards. The book addresses to professionals of the construction, geotechnical engineers, geologists, persons in charge of test laboratories and to the students in civil engineering, geology, mechanics, Earth sciences, mine engineering, environment and pedology.



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“Roberval prize” - from left: Prof. Laurent Vulliet, Prof. Sébastien Candel (President of the French Academy of Science) and Prof. Lyesse Laloui



At the same time theoretical and practical, this work proposes a detailed description of the nature and the composition of soils and rocks, deals with the modelling of boundary conditions problems and presents the tests allowing for the characterization grounds and rocks.

The problems of unsaturated soils and multiphase flows are also approached. Particular attention is given to the laws of mechanical behavior and to the determination of their parameters by in situ and laboratory tests. The work offers also a detailed description of the soil and rock classification systems, as well as the behavior of foundations, pressures on walls, stability of slopes and underground cavities.

BCV FOUNDATION

AWARDED TO PROF. LALOUI FOR HIS REVOLUTIONARY WORK IN ENERGY GEOSTRUCTURES

Professor Lyesse Laloui was a pioneer 20 years ago and today is the world leader in the research and development of energy geostructure technology. This technological revolution consists of taking advantage of the foundations of the buildings and the energy released by the subsurface to heat and cool infrastructures and buildings.

BCV Foundation annually awards 3 or 4 major personalities in the scientific, social, cultural or charitable fields. The prize granted to Prof. Laloui will benefit the promotion of energy geostructure technology.

TESTS
CARRIED OUT IN
1999
ON THE EPFL CAMPUS
WERE THE WORLD'S
FIRST

THIS
TECHNOLOGY
MEETS
70%
OF NEEDS OF THE
BUILDINGS



MOST IMPORTANT POINTS ABOUT THE TECHNOLOGY :



CLEAN AND INEXPENSIVE
PROCESS

The process naturally delivers renewable energy. From 5 meters depth, the soil is no longer affected by heat variations and enjoys a constant temperature throughout the year (13 degrees in Lausanne for example). The technology also benefits from structural elements that are essential to any construction, the foundations. Implemented with special tubes and a possible heat pump, the latter act as exchangers, accommodating heating or cooling water. The installation costs incurred, as well as those of maintenance of a possible heat pump, are amortized in a few years.



FROM LABORATORY TO
PRACTICE

Since 1999, the research team has managed to bring this innovation to maturity, playing a major role in the development of this globally recognized technology. But even though it is a pioneer in the field of research on energy geostructures, Switzerland is not taking advantage of its lead. Only about a hundred buildings, including a CEVA station and Terminal E at Zurich Airport, are equipped. The award HALL support large-scale diffusion of the process in new, in particular Swiss, constructions. A quarter of them could be equipped, drastically reducing the environmental impact of infrastructure.



MANY APPLICATIONS

The innovation meets the new European and international directives for carbon-neutral buildings, even with positive energy, drawing energy resources from the construction site, and is capable of acting within a radius of 500 meters. In addition to the buildings, many infrastructures can also benefit from this technology capable of de-icing the runway of an airport or the asphalt of a deck by equipping the piers of a bridge.



ADVANCED ERC GRANT



The research work of Professor Lyesse Laloui focuses on the mechanics and advanced microstructural inspection of porous geo-materials in interaction with hydraulic, bio-chemical and thermal phenomena. In his new ERC project entitled **BIOGEOS “BIO-mediated GEO-material Strengthening for engineering applications”**, Lyesse Laloui foresees pushing the boundaries of understanding around nature-based and bio-inspired, sustainable solutions for consolidating and strengthening Earth materials for construction and subterranean applications. The area of impact of BIOGEOS extends from foundation stabilization in urban zones, earthquake and liquefaction protection in seismic zones, to slope stabilization and soil erosion risk mitigation. The EPFL professor aims to crystallize the new knowledge produced during the project into constant and applicable innovation in the broader area of environmental geotechnics.

The ERC Advanced Grants are awarded to established, leading principal investigators who have a track-record of significant research achievements in the last 10 years



BIOGEOS - NEW PROJECT

BIOGEOS

BIOMEDIATED GEOMATERIAL STRENGTHENING

AIM & VISION

BIOGEOS mobilizes multidisciplinary and applicable research and a global vision of how geo-engineering practice can evolve towards a sustainable future. We aim to explore new concepts in ground reinforcement by meticulously designing the transition from ideation phase to validation and feasibility demonstrations at many scales, typically confronted in geo-technical applications and construction problems.

BIOGEOS builds on the knowledge and expertise developed at the Laboratory for Soil Mechanics of the Swiss Federal Institute of Technology during the past decade. From meticulously investigating theoretical and conceptual frameworks to extensively designing and delivering experimental campaigns, our group has contributed significantly to improving the understanding around bio-inspired design for geo-technical applications. At the crossroad of environmental geo-technics, bio-chemistry and material sciences, BIOGEOS consolidates the path towards the conception of innovative applications, which are expected to significantly impact the way we perceive and design efficient and sustainable construction applications. The next 5 years represent a continuous journey filled with incremental steps that aim to crystallize knowledge into constant innovation in our field.



FIELD TEST, OCTOBER 2018

7 INDUSTRIAL PARTNERS

6 TEAM MEMBERS OF OUR LAB

7 DAYS

300m³ TARGETED GROUND VOLUME FOR BIO-STABILIZATION

- largest experimental campaign yet, with **rich data series** at **multiple scales**.
- in October, we delivered 300 m³ of bio-stabilized ground in a **unique public - private partnership**:
- Soil erosion barriers, landslide and liquefaction risk mitigation, increased bearing capacity



Field tests - aerial view

BIOGEOS IS STRUCTURED IN THE THREE FOLLOWING WORK PACKAGES:

- Experimental Campaign
- Numerical Campaign
- Large-scale application

BIOGEOS TEAM:



Lyesse Laloui



Dimitrios Terzis



Patrick Hicher



Ray Harran



Ariadni Elmaloglou

CONTACT US:



<https://biogeos.epfl.ch/>



<https://twitter.com/BiogeosH2020>



biogeos@epfl.ch

PERSONAL ACHIEVEMENTS



PATRYCJA AWARDED FOR THE BEST PHD THESIS IN GEOTECHNICAL ENGINEERING IN POLAND IN 2017

The award funded by Professor Eugeniusz Dembicki is a prestigious distinction granted once a year to the author of the best doctoral dissertation in the field of theoretical and applied geotechnics. Dr. Baryła received the award from the hands of Professor Dembicki himself during the closing ceremony of the 18th National Conference on Soil Mechanics and Geotechnical Engineering, in Warsaw.

In the awarded doctoral dissertation “The Sand hydrophobized by alkoxysilane emulsions as an innovative material in geotechnics”, Patrycja undertook an interdisciplinary description of a new method of improving sand properties - hydrophobization. Hydrophobized sand can be used to protect underground parts of buildings placed in areas where a periodic increase in groundwater level is expected. For shallow foundations, hydrophobized sand plays a double role - it protects against water and at the same time transfers loads from the structure.

The Polish Comitee on Geotechnics (PKG) is polish national association of geotechnical engineers with high professional qualifications, employed in scientific and research institutions as well as in design and implementation enterprises.

PKG is an integral part of the International Association of Soil Mechanics and Geotechnical Engineering (ISSMGE).



MELIS WON THE AUDIENCE CHOICE AWARD AT THE 2018 PITCH YOUR IMPACT COMPETITION



© Greg Eaves / ENAC

At the second edition of Pitch Your Impact competition, which is run by Innoseed ENAC, an innovative geothermal energy system that can cut energy use drastically won the audience choice award. Melis’s project involves installing a new type of geothermal system in buildings, tunnels and subway lines, for example, so they can be heated and cooled with renewable energy.

For Melis the workshop was a fantastic experience, it let her see her research from a different angle. Winning the audience choice award showed her that people are interested in geothermal energy. That definitely encouraged Melis to continue developing her technology which could be applied on a large scale and have a major impact. The competition was also a great opportunity to meet other participants and learn about the wide range of research going on.

BENOÎT REWARDED FOR HIS MASTER PROJECT WITH THE PRIZE FROM IM MAGGIA ENGINEERING

On the graduation day, Benoît Cousin has been rewarded for his Master Project with the prize from the engineering firm IM Maggia Engineering rewarding each year the work of a Civil Engineering graduate in the areas of hydropower, tunnels or work below grounds. Benoît has been recognized with this prize for his project entitled “Energy performance and feasibility of an energy segmental lining for a subway tunnel”, proposing comprehensive information on the energy performance of innovative tunnels used as heat exchangers, as well as a breakthrough analysis of their economic attractiveness. A scientific paper is being elaborated following this project.



© Sedrik Nemeth

EPFL INNOGRANT AND ENAC BEST PAPER AWARD 2018 FOR DIMITRIOS

Our Scientist, Dimitrios Terzis, was awarded a prestigious **EPFL Innogrant** of 100’000 CHF to support his tech-transfer venture with MeduSoil in 2018. EPFL Innogrants were launched in 2005, with the support of Innovaud, Fondation Lombard Odier and others, and have financed more than 120 teams and helped to create 75+ start-ups. These start-ups subsequently received more than CHF 300M in additional grants and equity. The Innogrant supports Dimitrios in pursuing his efforts to bring the technology of soil bio-cementation from research to market. This breakthrough technology developed during Dimitrios’ PhD thesis is further described in his latest publication “3-D micro-architecture and mechanical response of soil cemented via microbial-induced calcite precipitation” in Scientific reports, a Nature Research journal. For this paper Dimitrios won the **ENAC best paper award 2018**. Articles published by the Nature Publishing Group are not targeting only scientists working in various fields but also a broader audience, interested in science. The topic of soil bio-improvement will be developed in our lab within the project BIOGEOS, led by professor Lyesse Laloui with the support of his ERC Advanced Grant.



© Michel Duperrex/ LaRegion

ALESSANDRO APPOINTED TENURE TRACK ASSISTANT PROFESSOR AT NORTHWESTERN UNIVERSITY, USA

JUST AFTER FINISHING HIS PH.D. AT THE SWISS FEDERAL INSTITUTE OF TECHNOLOGY IN LAUSANNE, ALESSANDRO F. ROTTALORIA HAS BEEN APPOINTED TENURE TRACK ASSISTANT PROFESSOR IN THE DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING AT NORTHWESTERN UNIVERSITY, IN THE USA

Alessandro will face this new challenge and opportunity to employ his competences acquired at the Politecnico di Torino, via his B.Sc. and M.Sc. degrees in Building Engineering, and at the Laboratory of Soil Mechanics of the EPFL, via his Ph.D. in Mechanics, with the aim of addressing both fundamental and applied problems at the interface of geomechanics, structural mechanics and energy.

The research activities of Alessandro’s group at Northwestern will address the understanding of the multiphysical and multiscale interactions between the built environment and the subsurface. The ultimate goal of his research activities is to contribute to sustain human development with a limited impact on the environment, by providing competences, tools and new approaches for the analysis, design and construction of urban systems characterised by a shift of paradigm compared to the present ones.



ALESSANDRO AWARDED DFI YOUNG PROFESSOR TRUST PRIZE

ON OCTOBER 28TH, DR. ALESSANDRO F. ROTTALORIA WAS AWARDED THE YOUNG PROFESSOR TRUST PRIZE FROM THE DEEP FOUNDATIONS INSTITUTE (DFI) IN ANAHEIM, CALIFORNIA, UNITED STATES

On October 28th, Dr. Alessandro F. Rotta Loria was awarded the Young Professor Trust prize from the Deep Foundations Institute (DFI) in Anaheim, California, United States. Since 1985, an annual Young Professor Paper Competition is held in the context of the Annual Conference of Dee Foundations organized by the DFI as a means to help bridge the gap between practice and study. This year, in the context of the 43rd Annual Conference on Deep Foundations, Alessandro has been recognized with this prize for his paper entitled “Performance-based design of energy pile foundations”

LMS IN THE MEDIA

TRACÉS

structures énergétiques
relable sous nos pieds

TRACÉS

re de mécanique des sols (LMS) de l'EPFL a fait œuvre de pionnier dans le domaine. Récemment récompensé par la Fondation pour ses développements techniques à large échelle de ce procédé.

Lux Peltier, Alessandro Rotta Loria, Lyesse Laloui

09.11.18
TRACES have published a long piece devoted to the activities of the LMS Laboratory, highlighting its many contributions to understand, describe and forecast the impacts of new technologies on the geotechnical design of structures. This article details how the laboratory prepares actual and future engineers, conducts research activities oriented towards technology transfer, and supports the industry through consulting.

PLAY RTS

20.09.18

Prof. Laloui gave an interview with RTS about the status of geothermal energy in Switzerland in relation to its progression in other countries. Prof. Laloui discussed how the challenges associated with geothermal energy are primarily technical and how the conditions in Iceland and Indonesia make geothermal energy exploitation easier than they would be in Switzerland.



Photo: © Sébastien Blanc

© Patrick Martin

L'EXTENSION

26.10.18

Highlights of the research conducted at the Chaire Gaz

Naturel – Pertrosvibri in the October edition of L'Extension. In the release of the L'Extension magazine the role of natural gas as an alternative source of energy was discussed.

In the article, the importance of the extensive research works in the field of CO2 sequestration of the Chaire Gaz Naturel – Pertrosvibri at EPFL, contributing to the leadership of Switzerland in the field is highlighted.

Gaz naturel et tournant énergétique

Gaznat investit massivement dans la recherche pour se positionner comme l'une des clés de voûte de la transition énergétique en Suisse. Une place que la société gazière a bien du mal à imposer aux politiques qui, pour des raisons idéologiques, ne sont guère favorables au gaz naturel. Dans ce contexte de défiance, le gaz a-t-il encore ses chances?

2018 offre l'occasion à Gaznat de célébrer son 50^e anniversaire; l'opportunité également pour la société gazière d'affirmer son ancrage dans le futur et ses efforts dans la recherche. En l'état, même si le gaz, troisième agent énergétique de Suisse derrière le pétrole et l'électricité, jouit d'une notoriété et d'un capital confiance auprès des consommateurs, son avenir pourait bien s'assombrir dans la perspective d'un monde sans énergies fossiles.

ÉNERGIE DE SUBSTITUTION À COURT TERME

En Suisse, la transition énergétique

rait être facilement compensée par les émissions de CO₂. En l'électricité, le gaz permet de remplacer la production des centrales nucléaires de se tourner vers des centrales à gaz. La réalisation de nouvelles infrastructures de transport de gaz est également une priorité.

La Région Nord vaudois

LA LIBERTÉ

18.07.18

“La Région” and “La Liberté” published articles about new project coordinated by Dimitrios Terzis who applied bio-cement to Rances soil. Rances in the north of Vaud suffered last year from the effects of large soil movement. Rances became the new playground where MeduSoil technology was tested as a remediation for this type of events. This is a decisive new step, after the technology has been extensively proven and tested in laboratory conditions.



bactéries pour soutenir le de Rances

Un projet pilote – Une première mondiale sera réalisée en terres nord-vaudoises, en septembre. Le laboratoire de mécanique des sols de l'EPFL va tester son ciment bactérien, une

energeia plus
Magazin des Bundesamts für Energie BFE



MECHANICS – THE KEY TO UNLOCK RESOURCES FOR ENERGY SUPPLY

05.10.18

Swiss Federal Office of Energy (SFOE) have published a short article mentioning activity of Laboratory of Soil Mechanics on their blog. The article was devoted to recent conference organized by LMS, namely The International Symposium on Energy Geotechnics. The conference underscored the importance of experimental geomechanics for the benefit of industries dedicated to energy geostructures, induced seismicity, gas hydrate sediments, nuclear waste disposal and CO2-storage. Prominent, internationally recognized specialists opened each day with a set of keynote lectures.

24 heures

18.06.18

24 Heures have published a long piece devoted to the activities of Prof. Lyesse Laloui. In this extensive

article, the professional story of Professor Laloui, from the beginning in his homeland Algeria, up to his most recent success, the award of the Advanced ERC Grant, is detailed.



© Patrick Martin

À l'EPFL, l'avenir de l'homme mûrit sous terre

Lyesse Laloui À la tête du Laboratoire de mécanique des sols, le professeur développe des connaissances permettant de réduire la pollution

English

The International Symposium on Energy Geotechnics organized by EPFL's Laboratory of Soil Mechanics brought together practitioners from 35 countries at the Swiss Tech Convention Centre in Lausanne to exchange

The conference underscored the importance of experimental geomechanics for the benefit of

23.05.18

Prof. Laloui discussed some of the major challenges facing CO2 geosequestration, a technology which could be vital in Switzerland's transition away from nuclear as this may mean increased reliance on natural gas. Many of these challenges, such as cap rock stability, induced seismicity, and thermal effects are central research topics in our lab.



20.04.18
The Swiss Technical Review “Swiss Engineering” published an article about the research of Dr. Dimitrios Terzis and Prof. Lyesse Laloui about soil biocementation.



Photo © Patrick Martin

09.03.2018

Professor Laloui gave an interview to Migros Magazine. The talk was about nuclear waste storage. As we know, disposal of nuclear waste abroad is forbidden since 2006 and therefore new solutions are being considered. The solution discussed is underground waste storage that could hold up to 100 000 square meters of radioactive waste.



10.01.18 - The ‘24 heures’ published an article to explain the functioning energy foundations.

The application of environmentally friendly technologies that exploit renewable energy sources is key to follow international agreements and directives for the development of carbon neutral buildings and infrastructures. Energy geostructures are an innovative, multifunctional technology that can be used to address the aforementioned challenge. By coupling the role of the ground structures with that of the geothermal heat exchangers, energy geostructures such as so-called energy piles, energy walls and energy tunnels can serve as structural supports as well as heating and cooling elements for buildings and infrastructures.

Nous faisons transiter de l'eau dans les tubes. Le fluide se réchauffe dans le sol. On crée en quelque sorte le radiateur du bâtiment»



Lyesse Laloui

Professeur à l'EPFL

«Cette blier en équipant les piles»



06.01.18

Interview of Prof. Lyesse Laloui at the RTS on the risks during the period of flood reduction. During the period of flood reduction, the level of water reduces more quickly than the pore water pressures in the ground of banks, which makes the risk of instability the highest.



PEOPLE



MEET THE TEAM

MANAGEMENT



DIRECTOR LYESSE LALOU
Full Professor

Dr. Lyesse Laloui is a chaired professor and Director of the Soil Mechanics Laboratory at the Swiss Federal Institute of Technology, EPFL, Lausanne, where he developed a major research group in the areas of Soil Mechanics, Geoengineering and CO2 sequestration. He is also Director of the EPFL Civil Engineering Section as well as adjunct professor at Duke University, USA. Prof. Laloui is also acting as advisory professor at Hohai University, China. His main research interests are in Geomechanics (Constitutive and numerical modelling of multiphysical coupling processes, laboratory advanced testing), and Environmental and Energy Sustainability (Nuclear waste underground storage, Petroleum Geomechanics, CO2 Geological Sequestration, Geothermal Energy).

OUR RESEARCH GROUP gives priority to the protection of environment, landforms and structures from geo-hazards and industrial damage.

Our experimental and modelling resources are mobilised to understand, investigate and predict the environmental impact of the new technologies



ALESSIO FERRARI
Senior Researcher

Dr. Alessio Ferrari is a research associate at the Soil Mechanics Laboratory at the Swiss Federal Institute of Technology of Lausanne. Dr. Ferrari is also associate professor of Geotechnical Engineering at the Università degli Studi di Palermo (Italy). His current main research interests are in Geomechanics for geo-energy systems, fundamental Soil Mechanics with a particular focus on unsaturated soils, development of advanced testing facilities for multiphysical testing of soils and shales, bentonite-based engineered barriers, experimental and constitutive analysis of the thermo-hydro-chemo-mechanical behaviour of complex geomaterials, and natural hazard assessment. He teaches the course of Slope Stability and Experimental Geomechanics at the EPFL. He serves in the board of the Doctoral School in Mechanics (EDME) of the EPFL.

POST-DOCTORAL RESEARCHERS

NEW
EMPLOYEE!

PATRYCJA BARYLA



Patrycja joined our team in December 2017. She gained her PHD title defending with distinction the thesis "The Sand hydrophobized by alkoxy silane emulsions as an innovative material in geotechnics" at Lodz University of Technology in Poland under the supervision of Prof. Marek Lefik. Patrycja's scientific interests are connected with a complex description of the phenomenon of wettability and the effect of this phenomenon on the filtration and strength properties of soils, as well as with the use of innovative soil reinforcement methods.

At LMS Patrycja is mainly involved in laboratory part of project BEACON. Under the supervision of Prof. Alessio Ferrari she leads the experimental works aiming to provide macro and micro characteristic of granular bentonite subjected to various hydro-mechanical conditions, the description of the behaviour on steel-bentonite interfaces as well as gas permeability of saturated bentonites.

Patrycja develops furthermore the experimental framework for testing the properties of bioimproved soils subjected to cyclic loading in drained and undrained conditions.

PATRICK HICHER

NEW
EMPLOYEE!

Patrick joined the laboratory of Soil Mechanics of EPFL in March 2018. He is a chemical-physicist. Patrick obtained his PhD of Materials Science in Paris-Saclay University (France) in December 2016 defending the thesis "Oxides crystal growth under external electric field" under the supervision of Dr. Raphaël Haumont and Prof. Patrick Berthet. Through his research work, Patrick Hicher brought insights on the thermodynamic and kinetic implications of applied high external voltage (tens of kV) to liquid-to-solid phase transformations of oxide materials.

Within the LMS group he is working on optimizing the process of Microbial Induced Calcite Precipitation in the framework of Project BioGeos.



ALDO MADASCHI

Aldo is currently involved in many projects concerning the numerical modelling of coupled problems related to nuclear waste disposal. In particular, he is working in the context of the SKB Engineered Barrier System Task force on the modelling of gas transport in compacted bentonite and is developing numerical approaches for "Anisotropy and self-sealing capacity of layered geomaterials" with the support of NAGRA.

Beyond these topics, Aldo's activities involve a wide range of geomechanical problems including the HM modelling of 3D excavation problems ("3D HM simulation of the sequential excavation of the new MB-A mine-by test at the Mont Terri rock laboratory", supported by Swisstopo) and the dynamic analysis of earth dams ("Seismic resistance of embankment dams with asphalt facing", founded by the Federal Office of Energy).

Aldo's teaching activities involve supervision of master student projects.



ALBERTO MINARDI

Alberto is currently working on the gomechanical characterization of geomaterials for the geological sequestration of carbon dioxide. On December 2017 he defended at the EPFL his PhD thesis entitled “Hydro-mechanical characterization of gas shales and Opalinus Clay shale in partially saturated conditions”.

His research activities are mainly developed in the context of the Work Package 1 of the Swiss Competence Center for Energy Research – Supply of Electricity (SCCER-So), where he actively supports the leadership and management of Prof. Laloui.

He is also involved in two other major projects related to the characterization of caprock formations for the underground storage of carbon dioxide: the CS-C experiment funded by Swisstopo and FANC, and the ELEGANCY project developed in the context of the European programme ACT (Accelerating CCS Technologies).

Alberto is also working in close collaboration with NAGRA on a consulting project dedicated to the analysis of a benchmark study on triaxial testing of Opalinus Clay. Finally, he is also actively involved in the organization and management of the master course “Geomechanics”.



DIMITRIOS TERZIS

Dimitrios has defended his PhD Thesis Kinetics, Mechanics and Micro-structure of Bio-cemented Soils under the supervision of professor Lyesse Laloui in 2017.

He is currently a post-doctoral scientist at our laboratory and a science entrepreneur supported by a prestigious EPFL Innogrant. Dimitrios is co-founder of MeduSoil LLC – a spin-off producing and commercializing a soil stabilization agent which produces mineral calcite in the subsurface. Thanks to the support of ENAC Innoseed and Enable programs, our scientist carried-out in the beginning of 2018 important development activities in collaboration with key Swiss industrial players in engineering bio-technologies to optimize the efficiency of the bio-cementation technology. These developments led to new intellectual property being developed and accelerated tech transition to real-field conditions confronted in multiple engineering problems. Currently more than 5 pilot projects have been successfully concluded with industrial partners (NDA protected) to evaluate the performance of bio-cementation with respect to various engineering applications.

ALESSANDRO FRANCESCO ROTTA LORIA

Alessandro defended his PhD thesis entitled “Thermo-mechanical performance of energy pile groups” at EPFL on December 2017, after joining the LMS in 2013. Currently, in the context of his post-doc at LMS, Alessandro is writing a book together with Prof. Laloui about the “Analysis and Design of Energy Geostructures”, which will be published in 2019. To further push the boundaries of the current development of the energy geostructure technology worldwide, Alessandro and Prof. Laloui are delivering an intensive short-course for practitioners and scientists entitled “Energy Geostructures: Analysis and Design”. Meanwhile, Alessandro is developing an EPFL spin-off co-founded with Prof. Laloui called GEOEG (www.geoeg.net), offering services to apply energy geostructures for the energy supply and structural support of urban environments. The main goal of this new experience is to transfer from research to practice the research and development activities about energy geostructures that have been initiated by Professor Laloui twenty years ago.

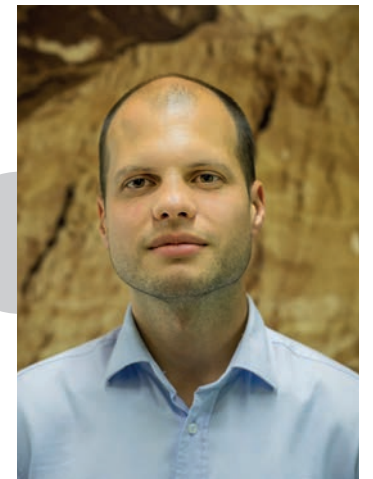


JOSE ANTONIO BOSCH LLUFRIU

Doctoral Assistant

Jose is currently working on development and validation of a numerical model for stress – strain behavior of compacted bentonites subjected to environmental actions. The model will be used to study and predict the evolution of clay buffers in nuclear waste repositories by means of finite element analysis. His project is supported by BEACON.

Jose is also participating in the teaching of the course of Soil Mechanics at bachelor level.



MELIS SÜTMAN



Melis is currently working within the Swiss National Science Foundation funded project “Cyclic Thermo-Mechanical Behaviour of Energy Piles”. The ultimate goal of the project is to administer a thorough knowledge on the response of energy piles subjected to cyclic temperature changes under a structural load, through an exhaustive experimental (in-situ and laboratory testing) and numerical campaign. She is also engaged in the project “Pieux Energétiques : Une Nouvelle Technologie pour une Energie Durable dans la Construction” funded by Fondation Banque Cantonale Vaudoise, the aim of which is to achieve the wide recognition of energy pile technology among civil engineers, architects, project owners and the society in the Canton of Vaud. Currently, the efforts in this project are focused on developing a finite element model to estimate the potential of energy piles corresponding to diverse building demands, as well as the assessment of the environmental impact of these geostructures through life cycle analysis. In 2018, Melis has actively worked in the organization of the International Symposium on Energy Geotechnics (SEG-2018), which was held in September 2018 at EPFL.



ETIENNE ANDRÉ CASSINI

Doctoral Assistant

Etienne is concluding his PhD thesis: Multi-scale thermo-chemo-mechanical modelling of MX-80 bentonite from atomistic description of clay-ions-water interactions

The first and main part of the thesis is dedicated to the computation of cation and water molecule density profiles between smectite platelets, in compacted bentonites, using Density Functional Theory. In a second part, it is shown that these results can be used to derive a constitutive model at the macroscopic scale. He is supported by Swiss Nuclear and supervised by NAGRA

When it comes to teaching, Etienne is involved in Master project supervision, courses in Geomechanics and Mécanique des sols.



ELEONORA CRISCI

—
Doctoral Assistant

All of Eleonora's activities in LMS are in the context of geological disposal of radioactive waste. She is currently working on 4 projects, all supported by NAGRA: Hydro-mechanical analysis of the behavior of Opalinus Clay shale sourced shallow depth with respect to the material mineralogical composition, Hydro-mechanical experimental analysis of Opalinus Clay behavior in unsaturated conditions, Thermo-hydro-mechanical experimental analysis of Opalinus Clay shale, in intact and remolded conditions and X-ray computed tomography evaluation of shale fissures and stratification.

Her teaching activities involve assisting in the courses at bachelor and master levels as well as the supervising of semester projects.



CRISTIANO GARBELLINI

—
Doctoral Assistant

Cristiano is working on soil-structure interaction of surface footings at ultimate limit state. His project is supported by Swiss National Science Foundation.

Cristiano is also participating in preparing exercises for bachelor's course: Mécanique des sols et écoulements souterrains as well as master's course on Geomechanics.

He is also supervising a master thesis on geotechnics.

ARIADNI ELMALOGLOU

—
Doctoral Assistant

Ariadni joined the Laboratory of Soil Mechanics (LMS), as a PhD Candidate on September 1st, 2018. She is involved in the BIOGEOS project, and the title of her PhD thesis is yet to be defined in the general field of soil bio-cementation. Before joining LMS, Ariadni acquired a M.Sc. in Environmental Engineering at Technical University of Denmark, where she conducted a Master thesis entitled "Characterization of contaminated sites with DCIP method: Rødekro case". She also holds a 5-year diploma in Civil Engineering from National Technical University of Athens, with specialization in Geotechnical Engineering.

NEW
EMPLOYEE!



RAY HARRAN

—
Doctoral Assistant

Ray has just joined the LMS as a doctoral student. The official title of his thesis yet to be defined in the general field of bio-cementation of soils, as part of the BIOGEOS project, funded by the European Research Council (ERC).

Before joining the LMS, Ray recently defended his master thesis entitled "Decision Aids for Tunneling – A Catalogue for application to small tunnels". His work was accomplished during an exchange between EPFL and the Massachusetts Institute of Technology (MIT) in the USA.

In addition to the teaching activities, lab and site work he is involved in, he is the current editor of the LMS website.

NEW
EMPLOYEE!



BARNABY PADRAIG FRYER

—
Doctoral Assistant

At LMS Barnaby is working on induced seismicity in relation to the injection/production of fluid from subsurface reservoirs, with a special focus on CO2 sequestration. Current research on the influence/management of poroelastic stresses induced during fluid production of hydraulic fracturing, depletion-induced permeability loss. The project is supported by SFOE.

Other topics of Barnaby's interest include: induced seismicity related to EGS, hydraulic fracturing, and waste water injection.

He is also involved in preparation of the master course on Geomechanics.



NEW
EMPLOYEE!

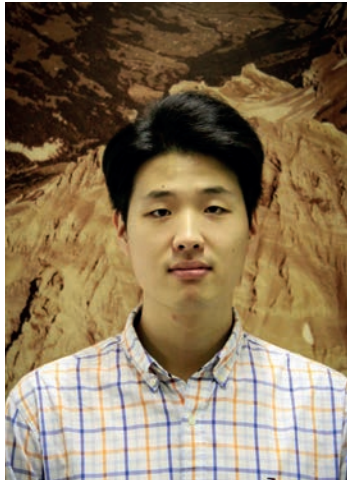


JINWOO KIM

—
Doctoral assistant

Jinu obtained his Master's degree in Geotechnical Engineering from Cornell University, USA. He carried out a project on the new subway transit center construction in New York City. He also received a second Master's degree in Structural Analysis of Monuments and Historical Constructions (SAHC) and defended his thesis titled "Seismic Vulnerability Assessment of Masonry Structures with the 3D Discrete Element Method" at the University of Padua, Italy.

At the LMS, he is working on the development of an effective stress law for gas shales in partially saturated conditions. The main approach encompasses designing an experimental campaign to measure the mechanical response of gas shales to suction variations. He is also supporting the public relations activities of LMS.



NEW
EMPLOYEE!

TAEHEON KIM

—
Doctoral Assistant

Taeheon joined our group in September. Prior to joining the LMS he completed his master's thesis on "Interplay between interparticle friction, dilation and strength" at Imperial College London using discrete element methods.

At LMS Tae is investigating the long term ground behaviour due to CO2 injection and chemical reaction between injected CO2 and the ground. A large part of his work is dedicated to developing THMC coupled analyses.



ANGELICA TUTTOLOMONDO

—
Doctoral Assistant

Angelica is working on the Chemo-Hydro-Mechanical behaviour of clayey soils and shales. Her current research activities concerns the definition of the effective stress for these geomaterial involved in multiphysics processes, the estimation of the in-situ effective stress (project funded by Nagra) and the development of an advanced constitutive model.

In 2017 she was assistant of the following Master's courses: Slope stability and Geomechanics. She is, with Prof. Laloui and Prof. Ferrari, the executive organizer of the Winter School dedicated to Geomechanics for Energy and the Environment (GETE Winter School) inaugurated in January 2018.

ELENA RAVERA

—
Doctoral Assistant

Elena is currently working on her PhD thesis entitled "Cyclic thermo-mechanical behaviour of energy piles" supported by Swiss National Science Foundation. The main objectives of her work are from a fundamental perspective to understand the long-term behaviour of energy pile groups subjected to cyclic thermo-mechanical load, for which very limited knowledge remains available to date. From a practical perspective, the current interest in the energy geostructure technology requires the development of simplified, yet reliable analysis and design tools.

Elena is also engaged in teaching activities for the courses at bachelor and master levels.



JACOPO ZANNIN

—
Doctoral Assistant

Jacopo's activities at LMS are developed in the context of energy geostructures. Particularly, he is dealing with Energy Walls, investigating the thermo-mechanical behavior and the hydro-thermal performances. He works in the framework of the Horizon 2020, Marie-Sklodowska Curie Actions Project Terre, funded by the European Commission.

He is also collaborating on an energy walls pilot project in Geneva, in collaboration with BG Ingénieurs Conseils and SIG – Services Industriels Genève.

Jacopo is also involved in teaching at Master and Bachelor levels, as well as supervising student projects.



RESEARCH ASSISTANTS

GIANLUCA SPERANZA

—
Doctoral Assistant

Gianluca is working on physical and numerical modelling for the sustainability of retaining structures in unsaturated soils in the framework TERRE European project. His work is supported by European Union.

He is also collaborating with French industrial partner Nobatek/Inef4.

Gianluca is involved in teaching on master level. He is also co-supervisor of a student from Politecnico di Torino for his Master Thesis Work.



STEFANO CINGARI

—
Scientific Assistant

Stefano's master thesis entitled "Feasibility Study on the Use of Energy Geostructures in Metro Stations: Application to the Grand Paris Express" was recently defended at EPFL.

At the LMS Stefano supports our technical manager with the preparation of expertise reports for industry. He is working on developing the codes for the analysis of laboratory results for various standard tests as well as establishing the testing procedures for temperature based oedometric tests.

NEW
EMPLOYEE!



NEW
EMPLOYEE!

BENOÎT COUSIN

Scientific assistant

Benoit recently defended his master thesis entitled “Energy performance and feasibility of an energy segmental lining for a subway tunnel”. Now as a continuation of his work, he is elaborating the scientific paper.

At the LMS Benoit is contributing to the research in Energy Geostructures comprising the development of design tools as well as the experimental study of energy textiles. Supporting the organization of the events organized by our group as well as editing the texts for the articles, he is also taking part in promotion of LMS activities.

SARAH CATHERINE DORNBERGER

Scientific Assistant

Sarah obtained her Master’s degree in Geology at the University in Lausanne. Her thesis entitled “Geologically-oriented design of a tunnel for geothermal use; determining the thermal properties of the Jura Mountains main rock formations” focused on the integration and use of geological knowledge in the applied geotechnical field.

With knowledge in geology and with a specialisation in geological risks, she will be working on bio-cementation and its long-term techno-economic feasibility, also in comparison with other methods currently used for soil stabilisation.

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MARGAUX PELTIER

Scientific assistant

Margaux has just defended at EPFL her master’s thesis on energy geostructures “Evaluation du potentiel thermique de la ligne de métro m3 de Lausanne”.

In her master thesis she investigated the thermal activation of the new urban metro line m3 of Lausanne. The presented results highlight how the urban environment can benefit from a large amount of heat stored in their subsurface.

AT LMS, Margaux works on a publication about the convection heat transfer driven by airflows in underground tunnels and supports the dissemination and communication of the contributions to the development of the energy geostructures technology.



NEW
EMPLOYEE!

Nothing would be possible without those people. Rosana, Barbara, Laurette, Wiola, Patrick, Samuel, Luc and Erwan are our KEY EMPLOYEES!

ADMINISTRATIVE STAFF



ROSA ANA TURIELLE

Secretary



BARBARA TINGUELY

Secretary



LAURETTE ROHRBACH

Public Relations



WIOLETTA KUCHARSKA

Public Relations

TECHNICAL STAFF



PATRICK DUBEY

Technical Manager



SAMUEL GRANGIER

Scientific Assistant



LUC MORIER-GENOUD

Technical Assistant



ERWAN ROMANN

Trainee

LMS AFTER HOURS

THINK BIG,
WORK HARD,
CELEBRATE !

May '18 - apéro St. Sulpice - the LMS team



September '18 - gala dinner in Olympic Museum
From left: Angelica, Eleonora



Septemeber '18 - gala dinner in Olympic Museum
From left: Angelica, Jose, Patrycja, Gianluca, Eleonora, Jacopo, Elena



November '18 - apéro after General Assembly

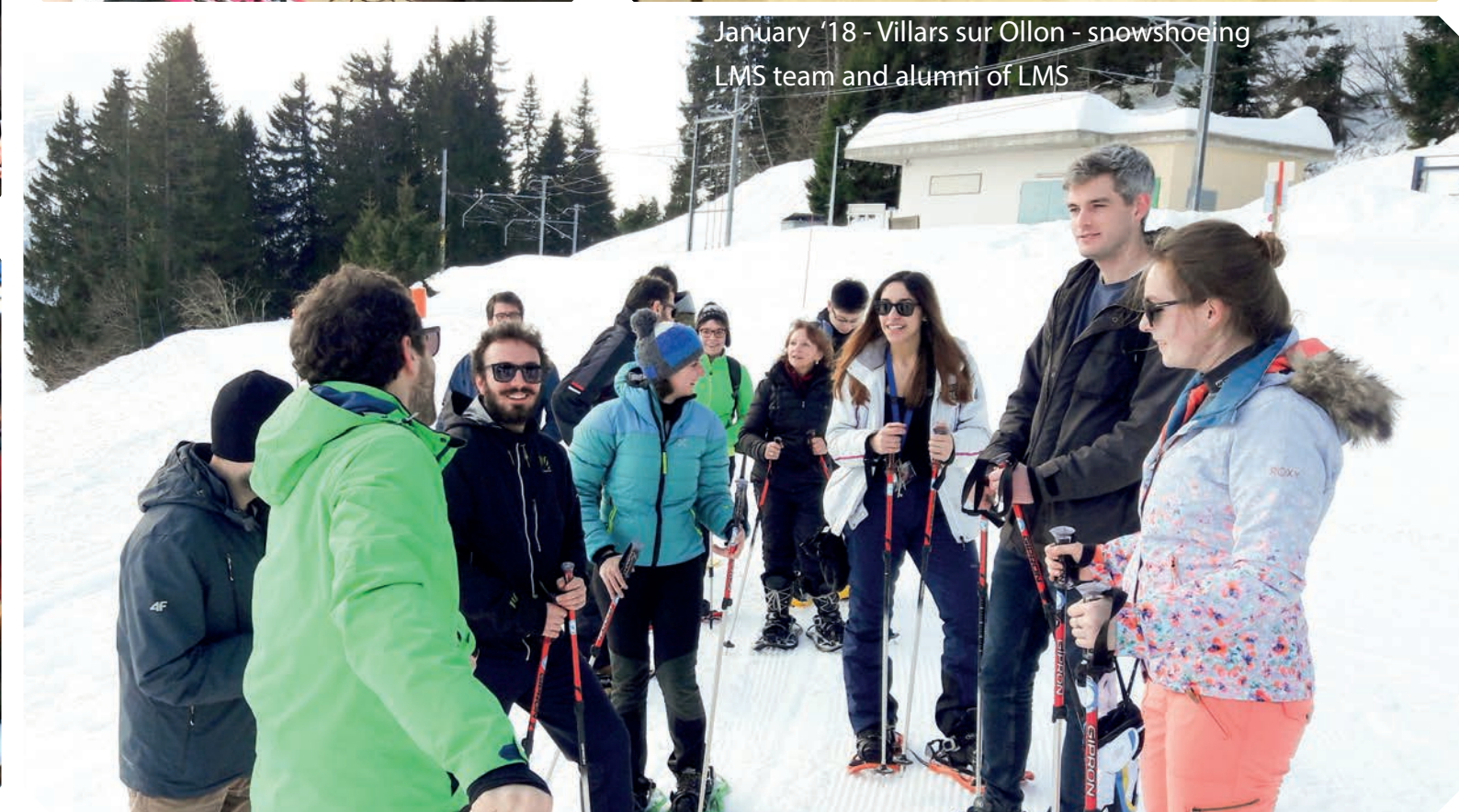
September '18 - gala dinner in Olympic Museum - Alessio



September '18 - gala dinner in Olympic Museum - Jacopo



January '18 - Villars sur Ollon - snowshoeing
LMS team and alumni of LMS



Document prepared by:

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Printing:

Atelier de reprographie EPFL

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