

ENIGMA ITN Meeting n°5

07/02/2019, Barcelona

Tour de Table

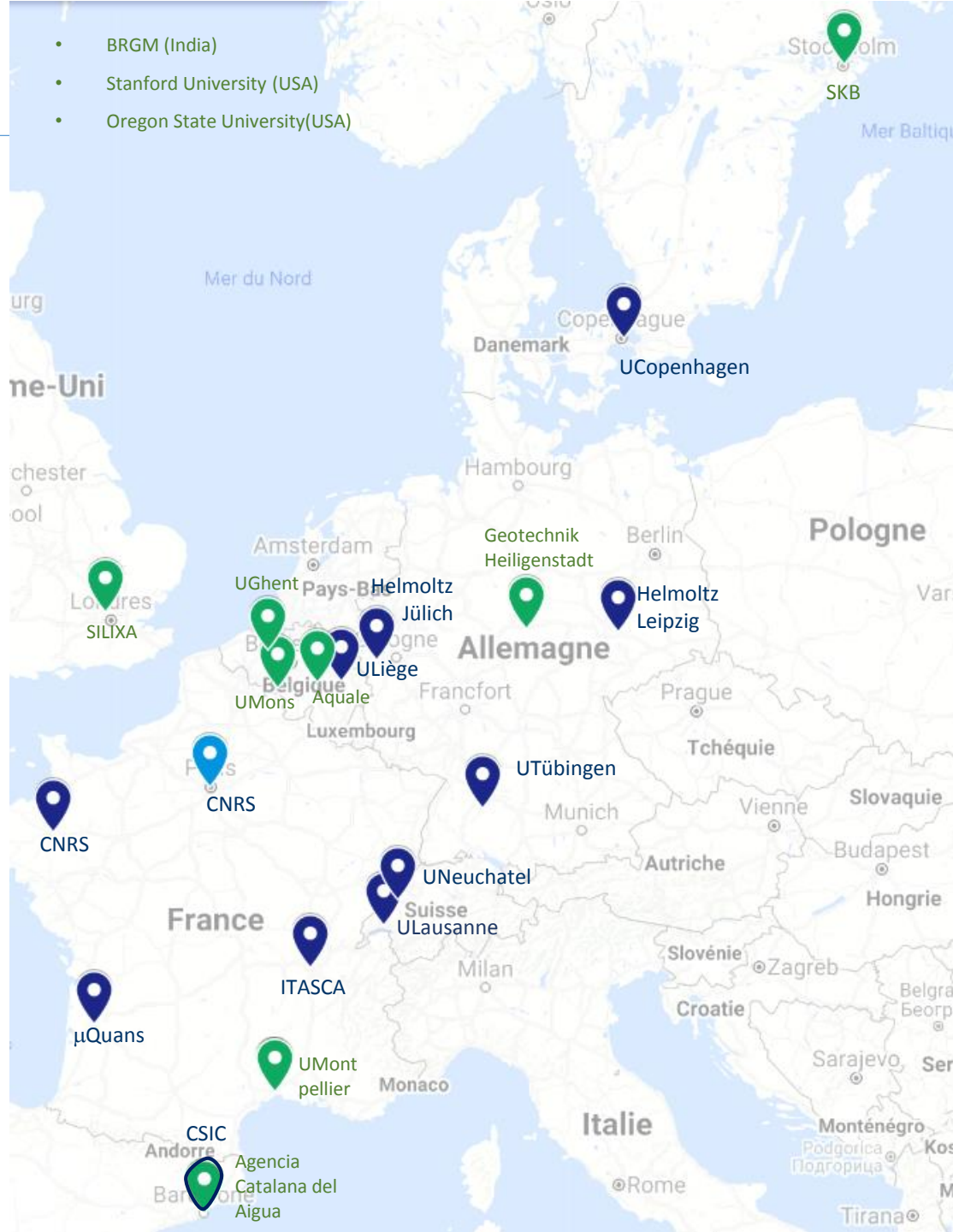


This project has received funding from European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Grant Agreement N°722028.



- BRGM (India)
- Stanford University (USA)
- Oregon State University(USA)

Enigma ITN Beneficiaries & Partners



Academic

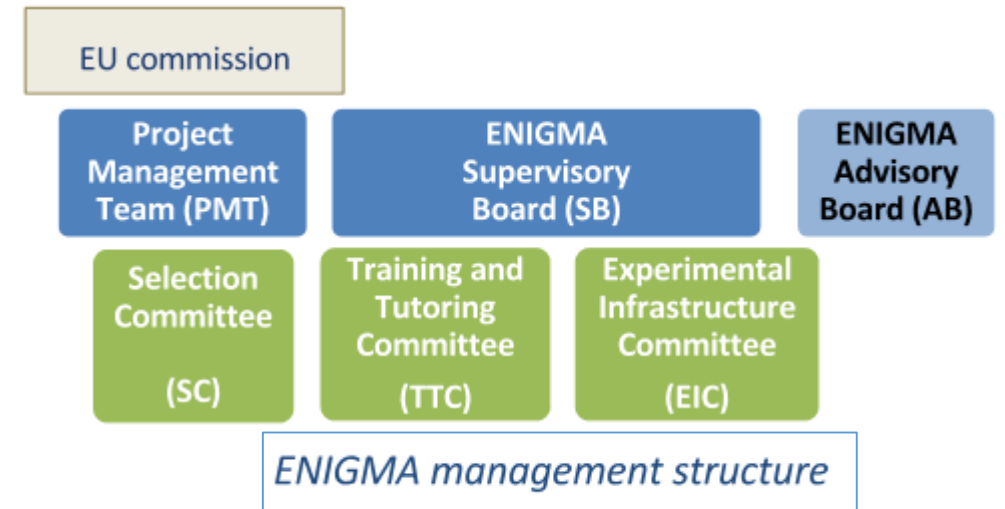
- CNRS H+: Rennes, METIS Paris (*Poitiers, Montpellier, LSBB*)
- Helholtz TERENO: Jülich, Leipzig
- CSIC Barcelone
- University of Liège, University of Mons
- University of Ghent
- University of Tübingen
- University of Copenhagen
- University of Lausanne
- University of Neuchatel
- University of Montpellier
- BRGM (India)
- Stanford University (USA)
- Oregon State University(USA)

Non-academic

- μQuans, ITASCA
- SILIXA, SKB
- Geotechnik Heiligenstadt
- Aquale
- Agencia Catalana del Aigua

Boards of Enigma ITN

- Supervisory board
- Advisory board



**Representatives for the Beneficiaries, referred to as “Members”
in the Consortium Agreement, with voting rights**

1. CNRS Rennes	Philippe Davy
2. CSIC Barcelona	Jesus Carrera
3. Forschungszentrum Jülich, Agrosphere Institute IBG-3	Sander Huisman
4. Helmholtz Centre for Environmental Research	Jan Fleckenstein (represented by Christian Schmidt)
5. University of Liège	Frédéric Nguyen
6. University of Tübingen	Olaf A.Cirpka
7. University of Copenhagen	Majken Looms Zibar / represented by Peter Engesgaard
8. University of Lausanne	Niklas Linde
9. Neuchâtel University	Philipp Brunner
10. µQuans	Bruno Desruelle
11. Itasca Consultants S.A.S.	Caroline Darcel

Representatives for the Partners, without voting rights

SKB	Jan-Olof Selroos
AQUALE	Guillaume De Schepper
University of Mons	Pascal Goderniaux
SILIXA	Athena Chalari
BRGM	Jean-Christophe Maréchal
Stanford University	Jef Caers
Oregon University	John Selker
University of Montpellier	Cédric Champollion
ACA	Mireia Iglesias Carrera

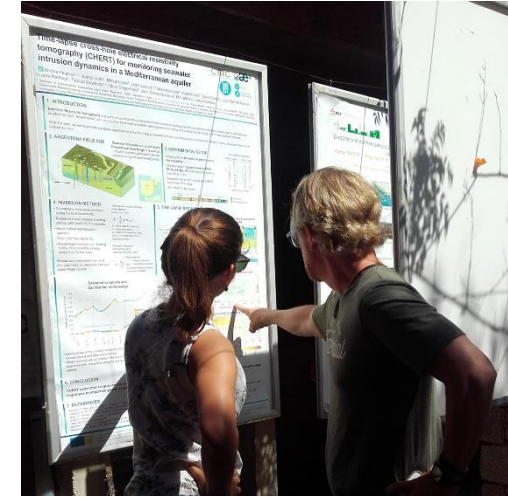
Representatives for the ESRs, without voting rights

Elected yearly, Elected in Liège in October 2017 and again in Cargèse in 2018
Alejandro FERNANDEZ VISENTINI & Veronika RIECKH



Advisory board

Beth Parker (University of Guelph, Canada),
Bridget Scanlon (University of Texas at Austin, USA),
Kamini Singha (Colorado School of Mines, USA),
Andrew Binley (Lancaster University, UK)
Ty Ferré (University of Arizona, USA).



Sub -committees

Selection Committee

Philippe Davy
Olivier Bour
Damien Jougnot
Jesus Carrera
Sander Huisman
Jan Fleckenstein
Frederic Nguyen
Carsten Leven-Pfister
Majken C. Looms Zibar
Niklas Linde
Philip Brunner
Cédric Champollion
Bruno Desruelle
Caroline Darcel
Athena Chalari

Training & Tutoring Committee

Frédéric Nguyen (ULG)
Jan Fleckenstein (UFZ)
Majken Looms Zibar (UCPH)
Caroline Darcel(ITASCA)
Olaf A. Cirpka (UT)
Philip Brunner (UNINE)
Maria Pool (CSIC)
Damien Jougnot (CNRS)
Sander Huisman (FZI)

The fellow tutor appointed by the SB during the second Enigma meeting in Liège (October 2017) is: Damien Jougnot (CNRS)

Experimental Infrastructure Committee

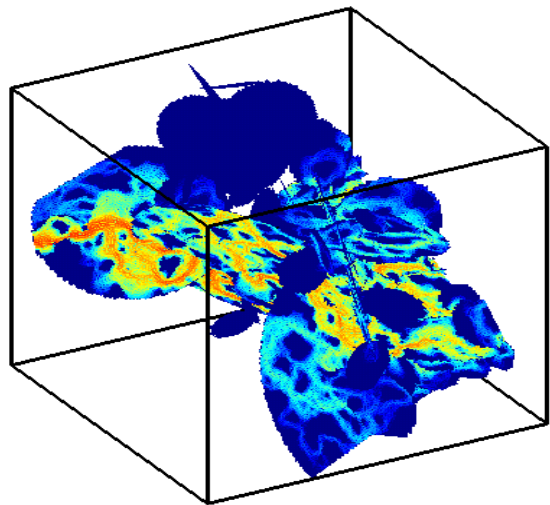
Laurent Longuevergne (Ploemeur)
Jan van Der Kruk (Krauthausen)
Alain Dassargues (Hermalle)
Carsten Leven-Pfister (Lauswiesen)
Jean-Christophe Maréchal (Hyderabad)
Jan-Olof Selroos (SKB) & Mats Ohlsson (SKB)
Nico Trauth (Leipzig)
Karsten Jensen (Hobe)
Philippe Brunner (Emme)
Maria Pool (Argentona)
Cédric Champollion (Larzac)
Konstantinos Chalikakis (LSBB)
<i>& 3 experts from the Advisory Board</i>
Kamini Singha
Bridget Scanlon
Ty Ferré





ITN Enigma

CNRS Coordination team: Philippe Davy, Tanguy Le Borgne, Damien Jougnot, Marie-Françoise Gerard

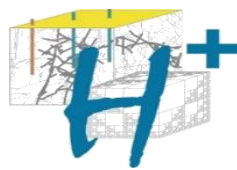


Research interests :

- Flow and transport in fractured rocks
- Mixing and reaction in porous media
- Hydrogeophysics

Implication within Enigma

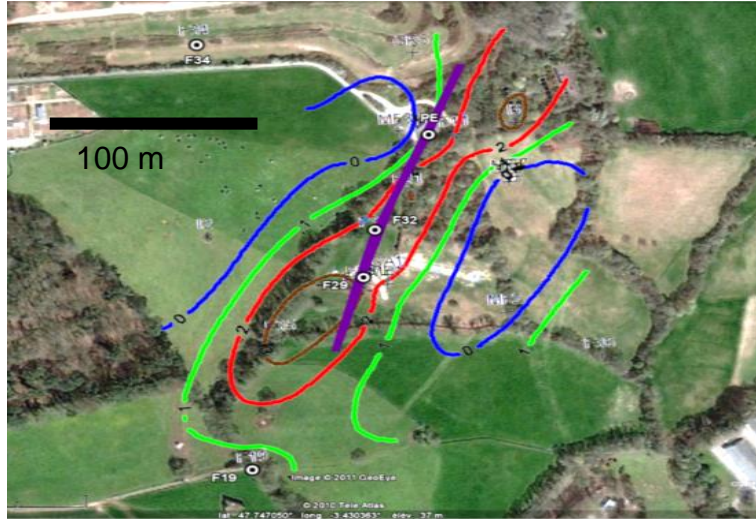
- Coordination of ENIGMA network
- Supervision of ESR 4,5 ; co-supervision of ESR 12
- Secondments for ESR 1, 9 and collaboration with ESR 11
- Organisation of Cargese summer school and Workshop 2
- Coordination of experimental infrastructure committee



Beneficiary 1. CNRS Rennes

Olivier Bour & Laurent Longuevergne





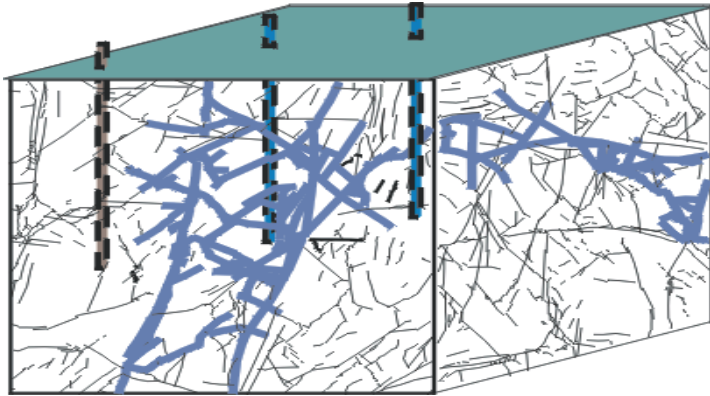
Research's interests :

- Hydrogeodesy – gravity and deformation to capture subsurface storage/permeable structures and flow
- Hydromechanical processes
- Contribution of groundwater within the water cycle

Implication within Enigma

- Co-responsible for ESR5 (Monitoring spatio-temporal water redistribution in the subsurface with seismic methods)
- Participate to ESR 6 (passive and active Fiber-Optic DTS methods to monitor subsurface flow dynamics)
- Responsible of Ploemeur Hydrogeological observatory





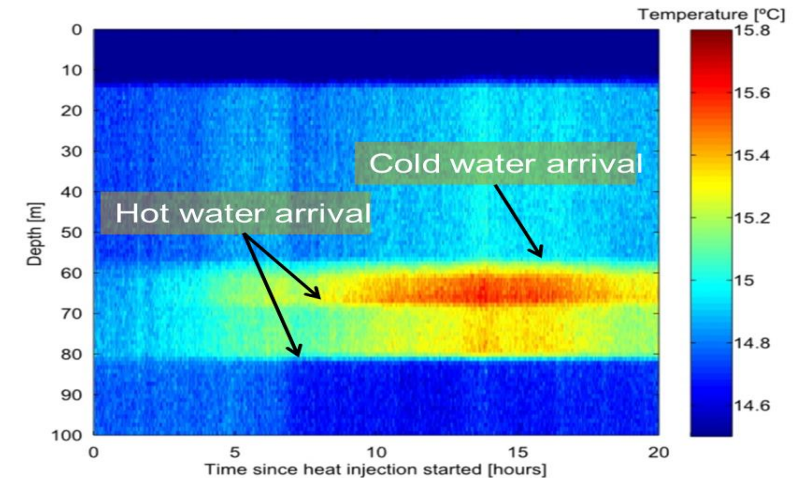
Research's interests :

- Fractured rock hydrogeology (fracture network modeling and flow and transport processes)
- Hydrogeophysics for imaging flow and transport processes
- Use of heat as a groundwater tracer

Implication within Enigma

- Responsible of ESR 6 (passive and active Fiber-Optic DTS methods to monitor subsurface flow dynamics)
- Responsible of 2nd workshop about Fractured rock hydrogeology
- Responsible of the H+ network of hydrogeological sites

Temporal evolution of the temperature profiles in the pumping well with fiber optic



Beneficiary 2. CSIC Barcelona

Jesus Carrera, Marco Dentz & Maria Pool



Beneficiary 3. Forschungszentrum Jülich, Agrosphere Institute IBG-3 Sander Huisman





FORSCHUNGSZENTRUM JÜLICH GMBH

Hydrogeophysics and high-resolution imaging and characterization

PROF. J.A. (SANDER) HUISMAN, PROF. JAN VAN DER KRUK, PROF. JAN VANDERBORGHT

DR. EGON ZIMMERMANN, DR. ANJA KLOTZSCHE

INVOLVEMENT

- Host for ESR10 (Peleg Haruzi) and ESR12 (Satoshi Izumoto)
- Member of the Recruitment and Training and Tutoring Committees
- Co-organized workshop I in Liege, Belgium
- Advanced courses for modelling GPR
- Krauthausen hydrogeological test site

Beneficiary 4. Helmholtz Centre for Environmental Research

Jan Fleckenstein represented by Christian Schmidt



The UFZ

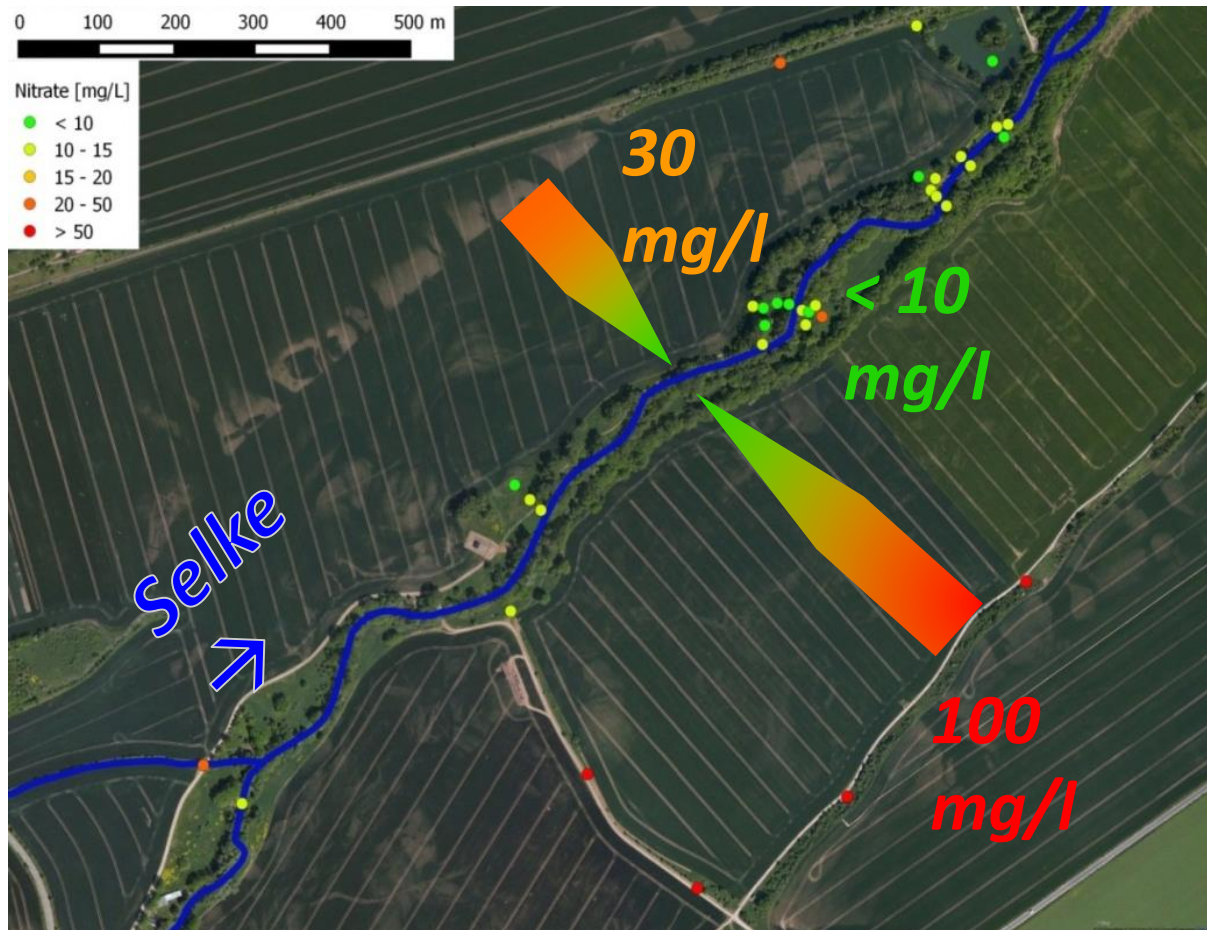


1,100 employees in total

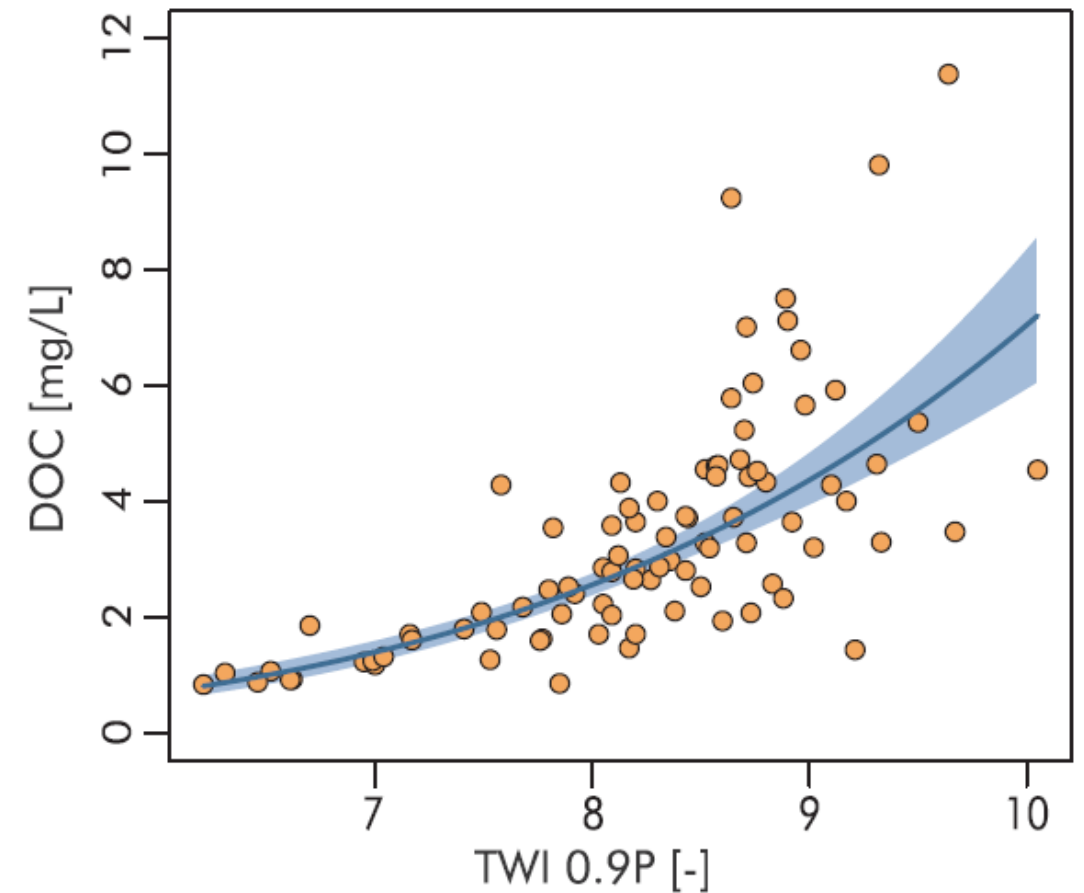
- thereof 880 scientists and scientific-technical staff
- 300 postgraduates
- approx. 550 guest scientists

The Department Hydrogeology

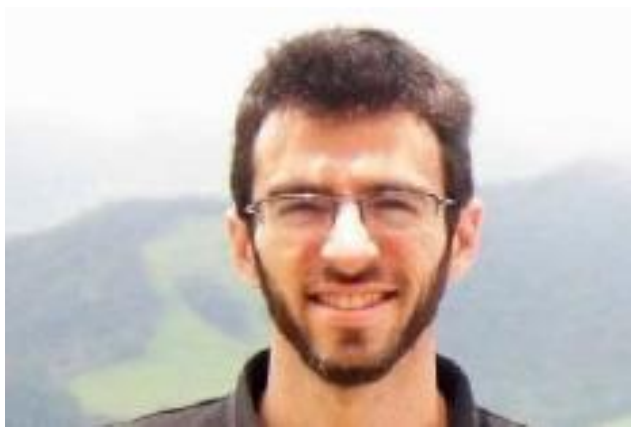
Water & solute dynamics in the transition zone between GW and SW



Top-down analysis & classification of catchment water & solute dynamics



Our team



Guilherme Nogueira

- ESR 2



Jan Fleckenstein

- Co-Head of Training
- Scientist-in-Charge



Christian Schmidt

- Co-Supervisor of Gui
- Coordination of Selke site activities



Joel Tirado Conde (ESR7)

Host : UCPH

Our role in ENIGMA

Operate one of the ENIGMA key field infrastructures: The Selke site

- Nested observatory
- Specifically instrumented for imaging reactivity at the interface between streams and riparian zones

Provide training and expertise on Groundwater-surface-water observation techniques and modelling

- OTC 7 on GW-SW Interactions
- Host ESR 3, 7 Secondments



Beneficiary 5. University of Liège

Frédéric Nguyen & Alain Dassargues



Beneficiary 5. University of Liège

Frédéric Nguyen & Alain Dassargues

11 Faculties
1 Hospital
24,000 students
2100 PhD students
10,000 staff



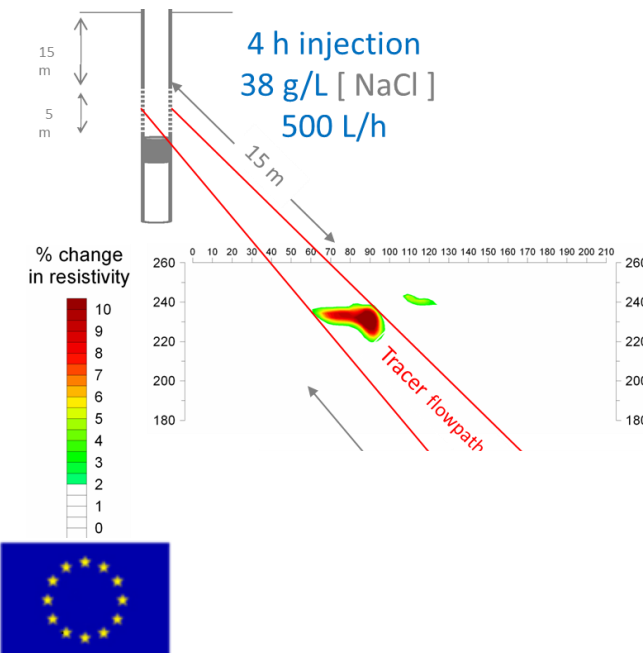
Engineering Faculty / Urban and Environmental Engineering Department /

- Applied Geophysics (Jorge)

Inverse problems

Data assimilation

Environmental Geophysics

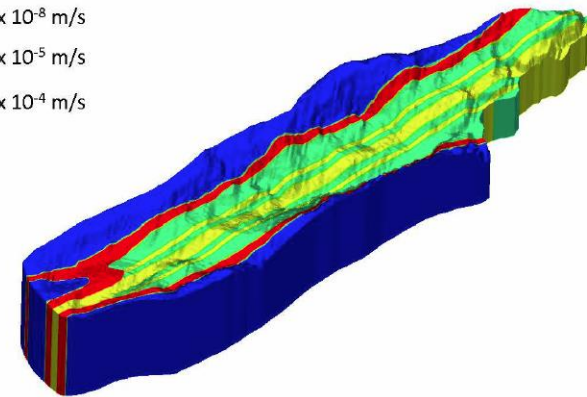
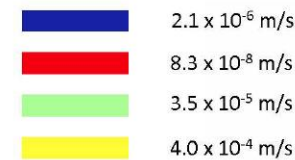


- Hydrogeology (Richard)

Quantitative groundwater modeling

Tracer and hydraulic tests

Contaminant hydrogeology



Role in the project

- Lead the WP training
 - Experience from past ITNs and EU projects
 - Strong involvement of the Research and Innovation Administration
 - Training and tutoring committee which oversees the training and the personal career development plans.
- Involved in the Supervisory Board and Selection Committee
- Supervise 2 ESRs: Jorge and Richard
- Secondment of Veronika Rieckh (joint modeling approach comparison and time-lapse data analysis)
- Provides Experimental field infrastructure of HSSA
 - Field training
 - H+ database training
 - ESR's data (Peleg in FZJ, DE)
- Links with Associated partners AQUALE, BRGM, Umons, Ugent involved in Training or Secondm.



Beneficiary 6. University of Tübingen

Olaf A.Cirpka & Carsten Leven



Beneficiary: Eberhard Karls Universität Tübingen, Germany

- Olaf A. Cirpka, Professor of Hydrogeology
Center for Applied Geoscience
- Specialized in
 - Groundwater modeling
 - Geostatistical parameter estimation and data assimilation
 - Field investigation techniques (pumping tests, tracer tests, direct-push surveys ...)
 - Reactive transport
- Experienced in inverting geoelectrical measurements in tracer tests to obtain hydraulic parameters (in the lab)

Role in ENIGMA

- Supervision of ESR 13, Veronika Rieckh, on inversion of 3-D salt-tracer tests
- Provision of Lauswiesen test site (alluvial aquifer in the Neckar valley)
- Coordination of Work Package 4: Inverse Modeling Strategies
- Lecturer in Workshop 3 (Bioreactive Transport) and at Cargèse Summer School

Beneficiary 7. University of Copenhagen

Peter Engesgaard & Majken Looms Zibar

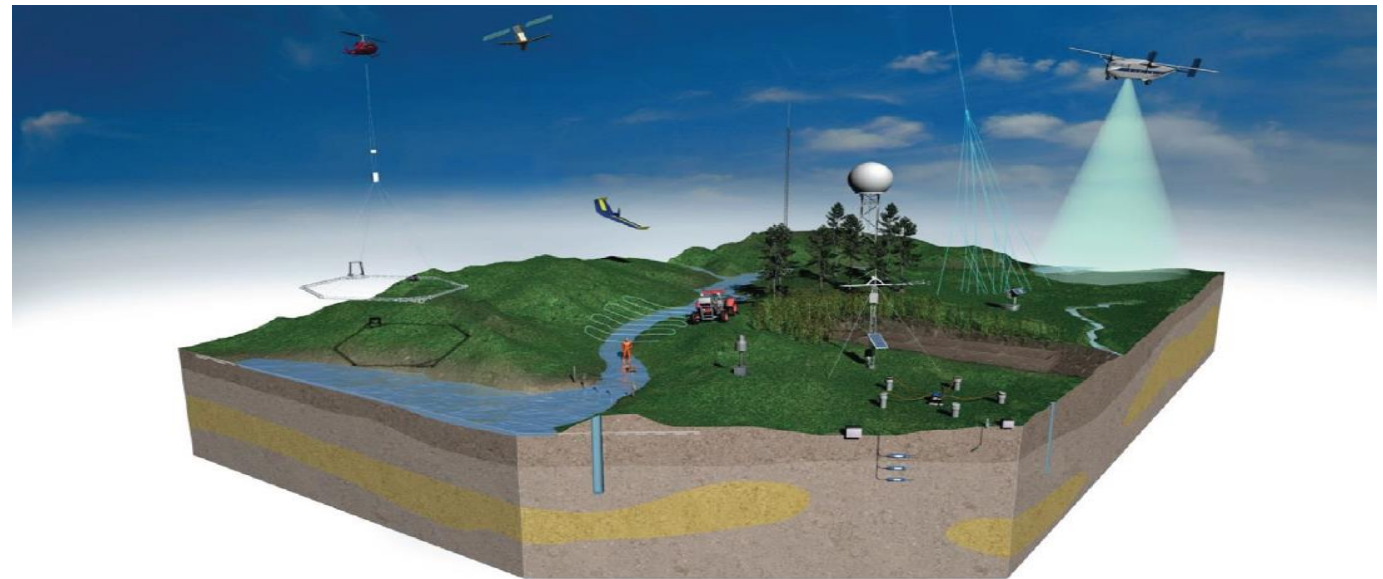


University of Copenhagen

- **ESR 7 – Joel Tirado Conde** ‘Multi-scale thermal imaging of groundwater upwelling in stream valleys’, supervisors Majken Zibar, Peter Engesgaard
- **Host secondments: ESR14** – Andrea Palacios ‘Geologically constrained joint inversion of hydraulic, tracer and ERT data for process visualization’, **ESR2** – Guilherme Nogueira ‘Imaging flow dynamics and resulting reactivity in the transition zone between streams and riparian aquifers’
- **Lead WP2** ‘*Enhance our capacity to monitor temporal changes in the spatial distribution of subsurface water content and fluxes*’
- **Experimental catchment:** HOBE – hydrological observatory (hobecenter.dk), Karsten H. Jensen
- **Host Optional Training Courses**
 - OTC7 ‘Surface-Groundwater Interactions’ to take place June or late summer 2019
 - OTC6 ‘Cosmic ray imaging of water content *might not run?*’
 - OTC new ‘Modeling of Geologic Heterogeneity and Groundwater’ is scheduled for June 2019
- Co-hosting **Final Conference and meeting in Copenhagen** ‘*Innovative methods for imaging heterogeneous aquifers: bridging the worlds of subsurface hydraulics, geophysics, geochemistry and microbiology*’

University of Copenhagen

- Department of Geosciences and Natural Resources Management (IGN)
- Geology Section – Geophysics and Water Resources
- Water Resources
 - 4 faculty members
 - 10 PhDs
 - 1 post doc
- HOBE catchment
 - Cosmic Ray
 - Cross-bore hole geophysics
 - UAV-TIR
 - DTS



Beneficiary 8. University of Lausanne

Niklas Linde



UNIVERSITY OF LAUSANNE

Our expertise is (hydro)geophysics, inversion and millifluidics
Prof. Niklas Linde and Prof. Pietro de Anna



INVOLVEMENT

- Chaired the recruitment committee
- Organized workshop IV; hosted workshops III and IV; hosted the third ENIGMA ITN meeting
- Main host of ESR 9 (Alejandro Fernandez Visentini)
- Host of secondments: ESR1 (Kevin de Vriendt); ESR4 (Justine Molron); ESR5 (Lara Blazevec); ESR 6 (Behzad Pouladi); ESR10 (Peleg Haruzi); ESR14 (Andrea Palacios)

Beneficiary 9. Neuchâtel University

Philipp Brunner



Research

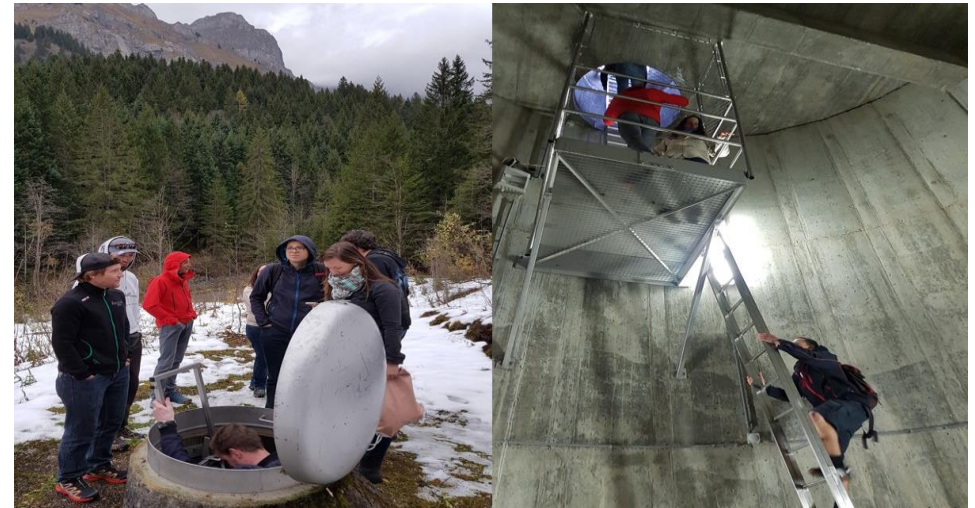
5 Research labs:

- Geothermics and Geodynamics (S. Miller)
- Geothermics and Geomechanics (B. Valley)
- Contaminant Hydrogeology (D. Hunkeler)
- Stochastic Hydrogeology (P. Renard)
- Hydrogeological Processes (P. Brunner)



Teaching

- Master program in Hydrogeology
- Several MAS/CAS (Geothermics, contaminant hydrology, WATSAN cours)
- PhD school in collaboration with UNIL & EAWAG



Involvement in ENIGMA

Key competences

- Physically based numerical modelling of hydrological and hydrogeological processes
- Tracer approaches

Staff and Staff exchange

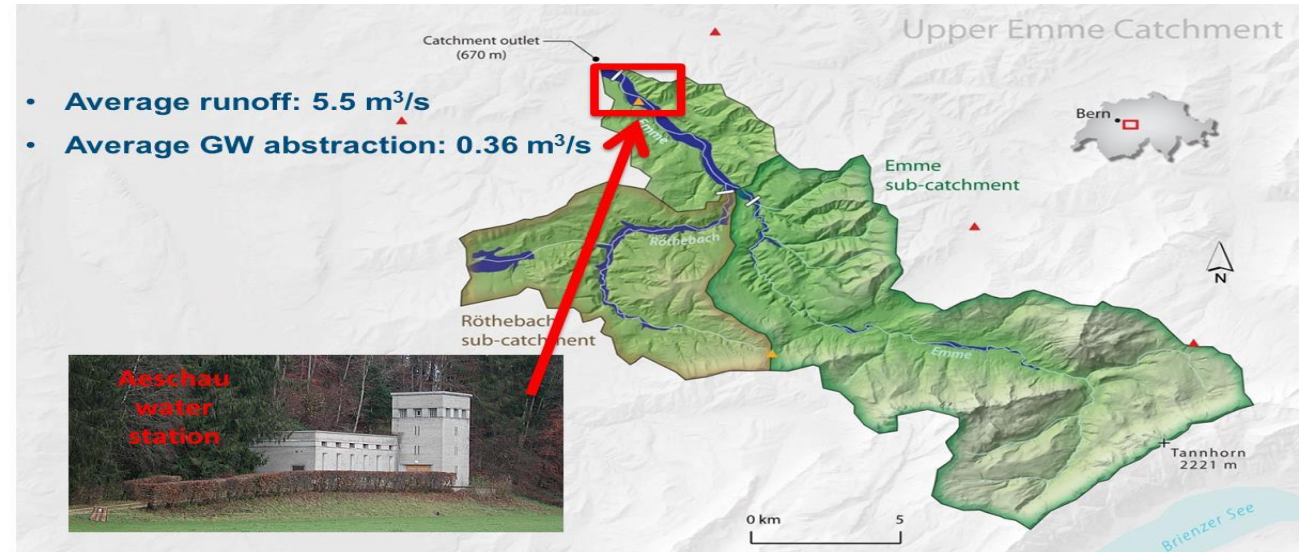
- PhD student Alvaro Pardo
- Secondments (e.g. Exchange with UFZ)

Teaching activities in ENIGMA:

- Course in Multiple Point Statistics (Lausanne, 2018)

Fieldsite:

- The Emme site



Beneficiary 10. μQuans

Bruno Desruelle



General information

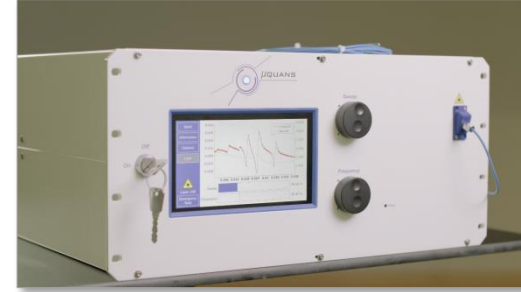
- Created in 2011.
- World leader in quantum sensing :



Absolute Quantum Gravimeter



MuClock



Laser systems

- A unique technology based on laser-cooled atoms
- 28 employees (15 PhD)



Role in ENIGMA

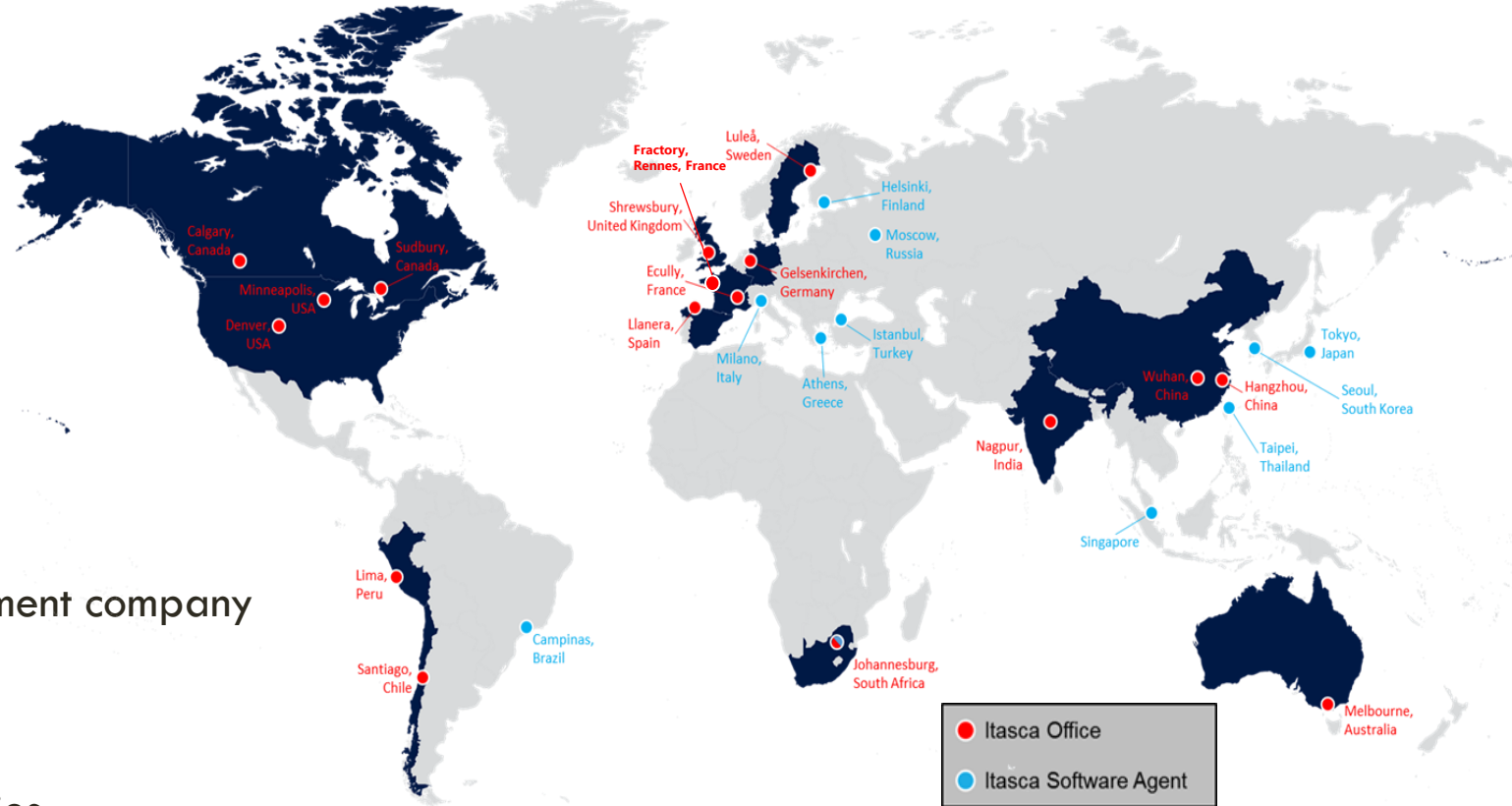
- Test and validation of the instrument in the H+ Larzac site.
- Monitoring of karstic aquifers
- Work in close interaction with University of Montpellier :
 - Measurements performed at GEK observatory
 - Scientific advisors : Cédric Champollion and Nicolas Le Moigne
- Supervision of Anne-Karin Cooke

Beneficiary 11. Itasca Consultants S.A.S. Caroline Darcel



Itasca - Introduction

- Engineering consulting and software development company
- Founded in Minneapolis, Minnesota in 1981
- 170 personnel among 16 offices in 13 countries
- Geomechanical, hydrogeological, materials handling and microseismic challenges in civil, manufacturing, mining, oil & gas, geothermal energy, (nuclear) waste isolation
- Itasca Consultants sas (ICSAS) started in France in 1991
- Since 2017 ICSAS opened an office in Rennes to start the *fractory* - a Joint Laboratory between ICSAS and University of Rennes / CNRS



Itasca involvement in Enigma ITN

Justine Molron

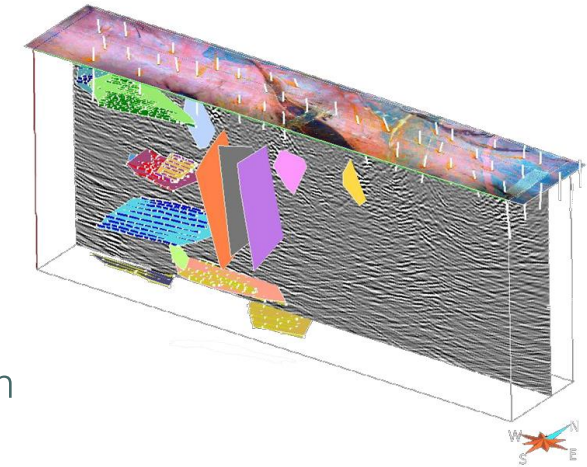


Itasca hosts ESR 4

Flow and transport in fracture networks: reducing uncertainty of DFN models by conditioning to geology and geophysical data (Ground Penetrating Radar – GPR)

Itasca contribution to workshops

- Ploemeur Fall 2017- Introduction to DFN modeling –
- Cargese Summer School Summer 2018 - Rock mass effective properties from a DFN approach
- Barcelona Feb 2019 - Start-up/technological transfer/female and PhD in industry



Partner. SKB

Jan-Olof Selroos



The Swedish Nuclear Fuel and Waste Management Company (SKB)



SKB's mission:

“Regardless of the future of nuclear power, nuclear waste exists today from the Swedish nuclear power plants.

This waste must be taken care of to protect people and the environment.

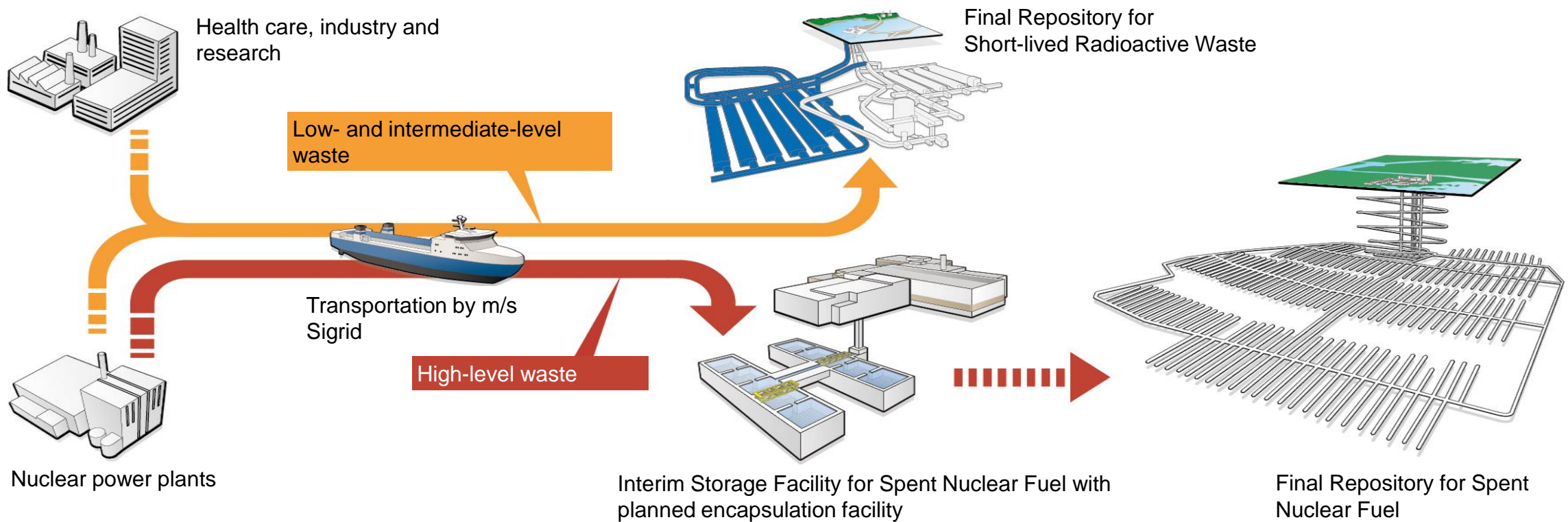
This task is so extensive that we regard it as one of Sweden's most important environmental protection projects.”

Jan-Olof Selroos

Mid term review meeting, February 7, 2019



SKB's concept for geological disposal of nuclear waste



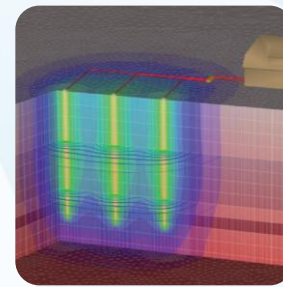
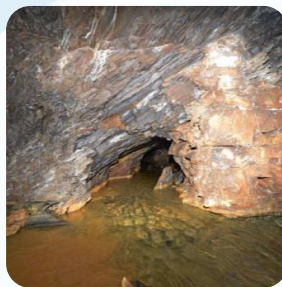
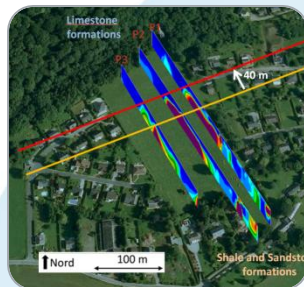
Partner. AQUALE

Guillaume De Schepper



Who we are

- Environmental services SME (10 employees), based in Belgium.
- Hydrogeology, hydrology, geology.
- Engineering (field work, modelling), permitting.
- Clients in Belgium, France, Italy, Brazil, Canada,...



Our involvement in the project

- Partner organization.
- Collaboration with Prof. Frédéric Nguyen (ULiège).
- Host institution for Jorge Lopez-Alvis (ESR 15), planned secondment: 31/03/2020 – 31/05/2020.
- *Integration of dynamical hydrogeophysical data in a multiple-point geostatistical framework.*



Partner. University of Mons

Pascal Goderniaux





Involved in co-supervision of ESR 11 (Richard HOFFMANN) with ULiège
Joint heat and solute tracer test inversion for imaging preferential pathways

- Tracer experiments and modelling in fractured chalk
- Use of various tracer fluids to characterize the reservoir (fluorescent tracers, heat, dissolved gases)



Partner. SILIXA Athena Chalari



Silixa –company & technology



About Silixa

Established in 2007, Silixa employs 64 people and is backed by 3 major investors.



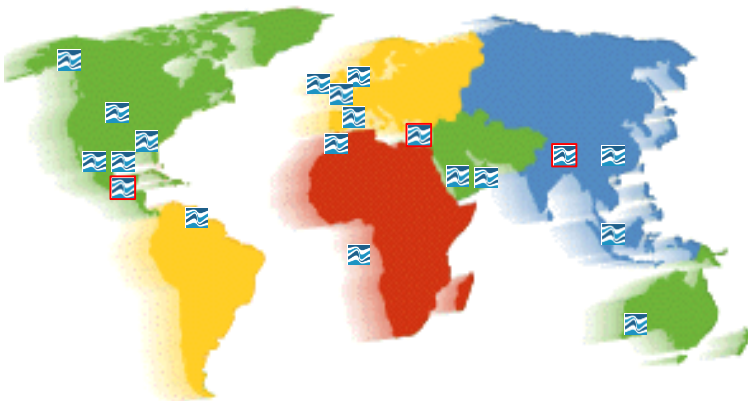
What we do

Silixa improves performance, reduces operational costs and extends the lifespan of any asset by delivering distributed fibre optic monitoring solutions on both new and existing fibre cable installations with the highest levels of accuracy in the industry. We have successfully completed hundreds of fibre optic distributed sensing installations worldwide.

Our mission

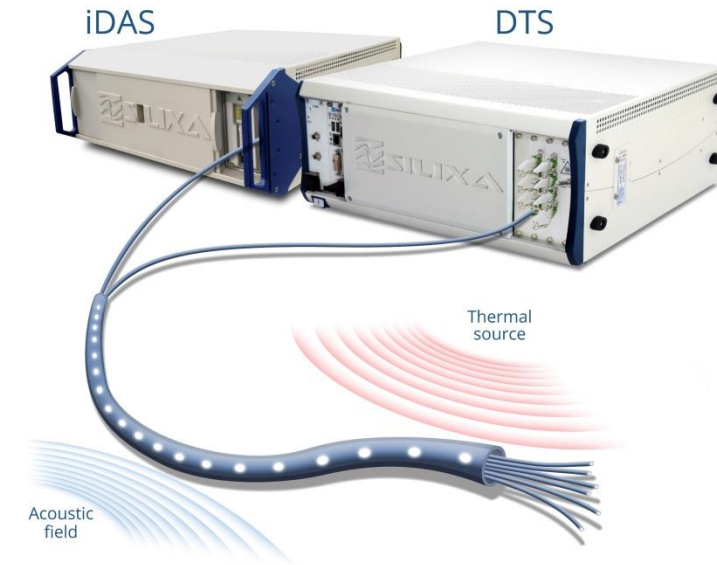
To enable our customers to redefine the limits of possibility within their processes by transforming how distributed sensing is used.

Our industry footprint



Our technology

Converts standard telecom optical fibre into a **high-precision microphone** and **thermometer** – at an infinite number of measurement points along the length of fibre.



Why chose Silixa

- Unique in being the only originator and manufacturer of both “best in class” DTS and iDAS technology
- In our chosen sectors we have embedded deep knowledge in our highly responsive multidisciplinary teams
- We continue to extend the envelope by making significant investment in research & development
- We have a long track record of success and are ISO 9001 and Achilles certified



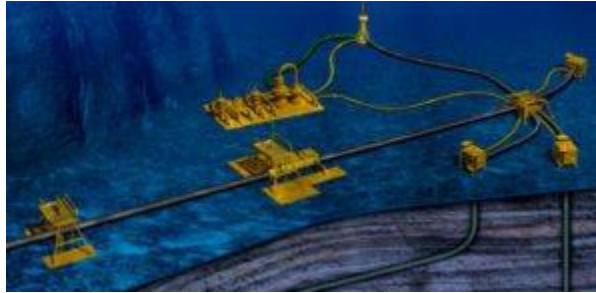
Silixa – served sectors today



Oil & Gas Downhole



Oil & Gas Subsea



Mining



Environmental & Industrial



Permanent Reservoir & Well Services

- Carina® Seismic
- Seismic
- Production Profiling
- Well Integrity

Intervention Services

- Fluid Inflow Detection
- Water/EOR Injection & Stimulation Monitoring

Frac Services

- Carina® XwellXpress™
- Fracture monitoring
- Crosswell monitoring
- Flowback monitoring

Cable mapping

Pipe and cable integrity

- Subsea event detection
- Subsea leak detection
- Subsea power monitoring

Flow assurance

- Slug detection
- Thermal profiling

- Process flow metering
- Seismic and VSP
- Seismicity (Mining)
- Tailings dam monitoring

Geotechnical

- Geothermal monitoring
- Groundwater
- Seismicity (Geotechnical)

CO2 Storage

- Cavern integrity
- Plume monitoring
- VSP and surface seismic

Asset integrity

- Dam monitoring
- Integrity monitoring
- Power cable monitoring
- Process monitoring

Products

- XT-DTS
- ULTIMA™DTS
- iDAS™
- Cable & Accessories



PARTNER ORGANISATION

Support training activities in ENIGMA on DTS fibre-optics through secondments and participation in workshops and summer schools.

Industrial lead in WP1: Spatially distributed sensing of flow and hydraulic properties

Development and field validation of novel technologies and methodologies for characterizing the spatial distribution of flow and hydraulic properties in the subsurface

ESR secondment

Partner. BRGM

Jean-Christophe Maréchal



BRGM THE FRENCH GEOLOGICAL SURVEY



Geoscience for a sustainable Earth

brgm

BRGM

THE FRENCH GEOLOGICAL SURVEY

The BRGM is France's public reference institution for Earth Science applications for the management of surface and subsurface resources and risks. Its activities are geared to scientific research, support to public policy development and international cooperation.

Understanding

geological phenomena and associated risks.

Developing

new methodologies and techniques.

Producing and distributing

and disseminating data to support the management of soils, subsoils and their resources.

Delivering

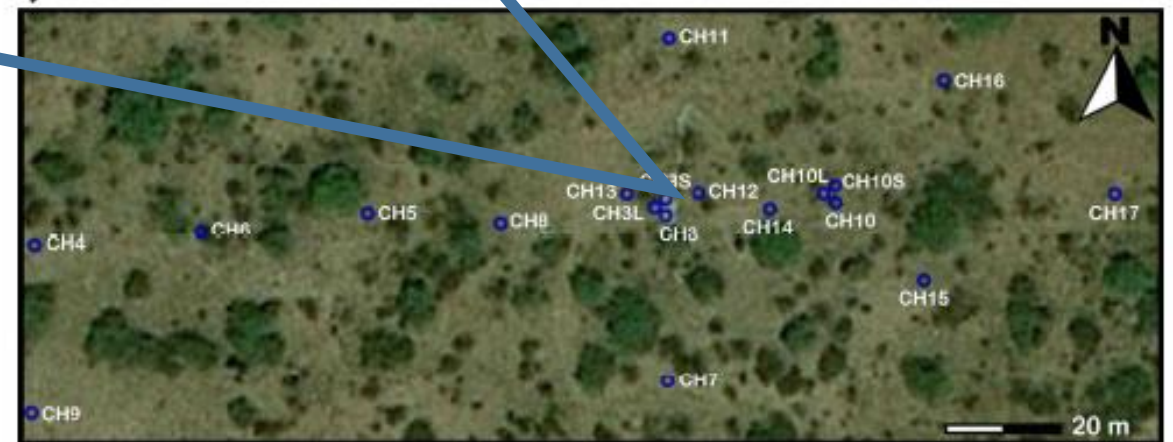
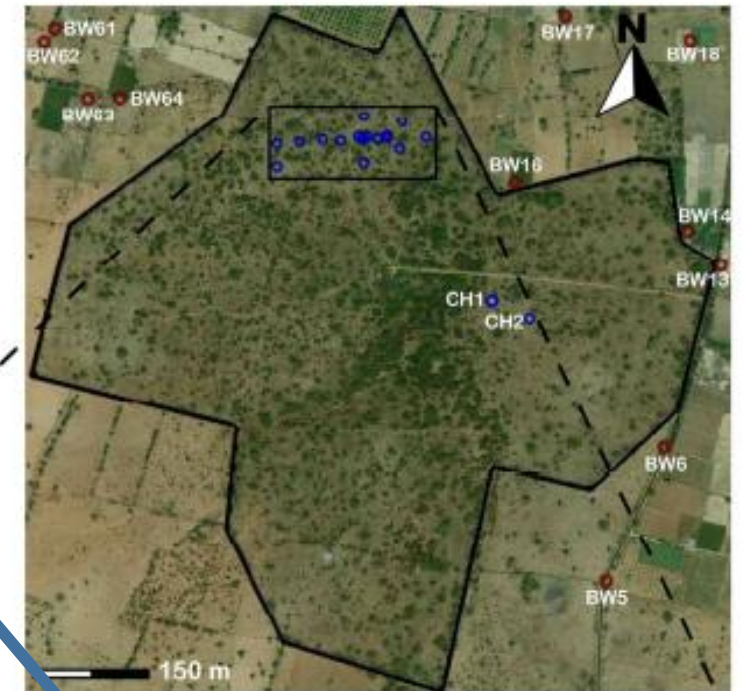
the necessary tools for managing soils, subsoils and their resources, preventing risks and pollution and developing climate change policies.

**Over
1000 staff**

including more
than 700
engineers and
researchers

TEAM: New Water resources and Economy (NRE)

Experimental site in India



Partner. University of Ghent

Thomas Hermans



Department of Geology – Hydrogeophysics Research Unit

Assistant Professor Thomas Hermans

- Hydrogeophysical inversion
- Uncertainty Quantification
- Team = 4 PhD students (+ 2 to come in 2019)

“New partner” of the project



Involvement in ENIGMA

Organization of Workshop 1: Advanced subsurface characterization method

Supervision of ESRs

Jorge Lopez-Alvis

- Co-promoter + Secondment
- Popper-Bayes falsification + Bayesian Evidential Learning

Richard Hoffman

- Unformal supervision
- Global sensitivity, prior uncertainty

Lara Blazevic

- Collaboration
- Time-lapse ERT inversion

