The CRITEX project:

Challenging equipments for the temporal and spatial exploration of the Critical Zone at the catchment scale

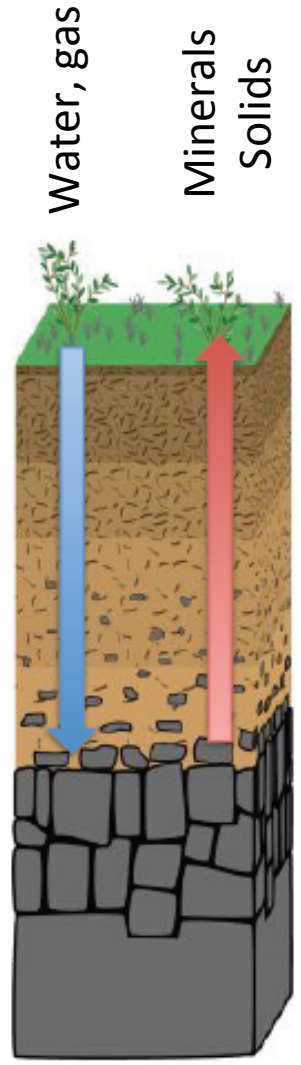
PI : **Jérôme Gaillardet** (IPG Paris)

Co-PI : **Laurent Longuevergne** (Géosciences Rennes)

RÉSEAU DES BASSINS VERSANTS

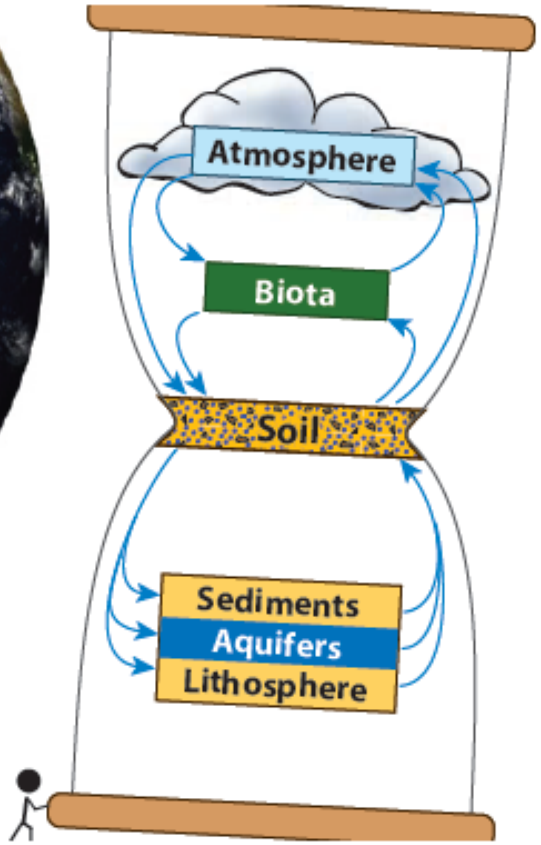
INVESTISSEMENTS D'AVENIR

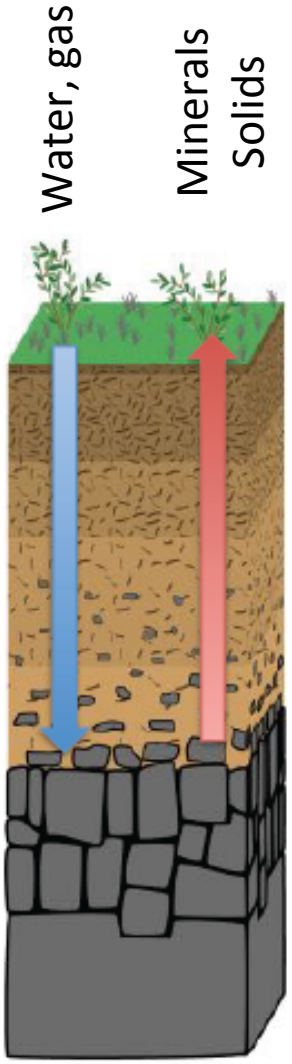
The critical zone : between Sky and Rocks



The critical zone : between Sky and Rocks

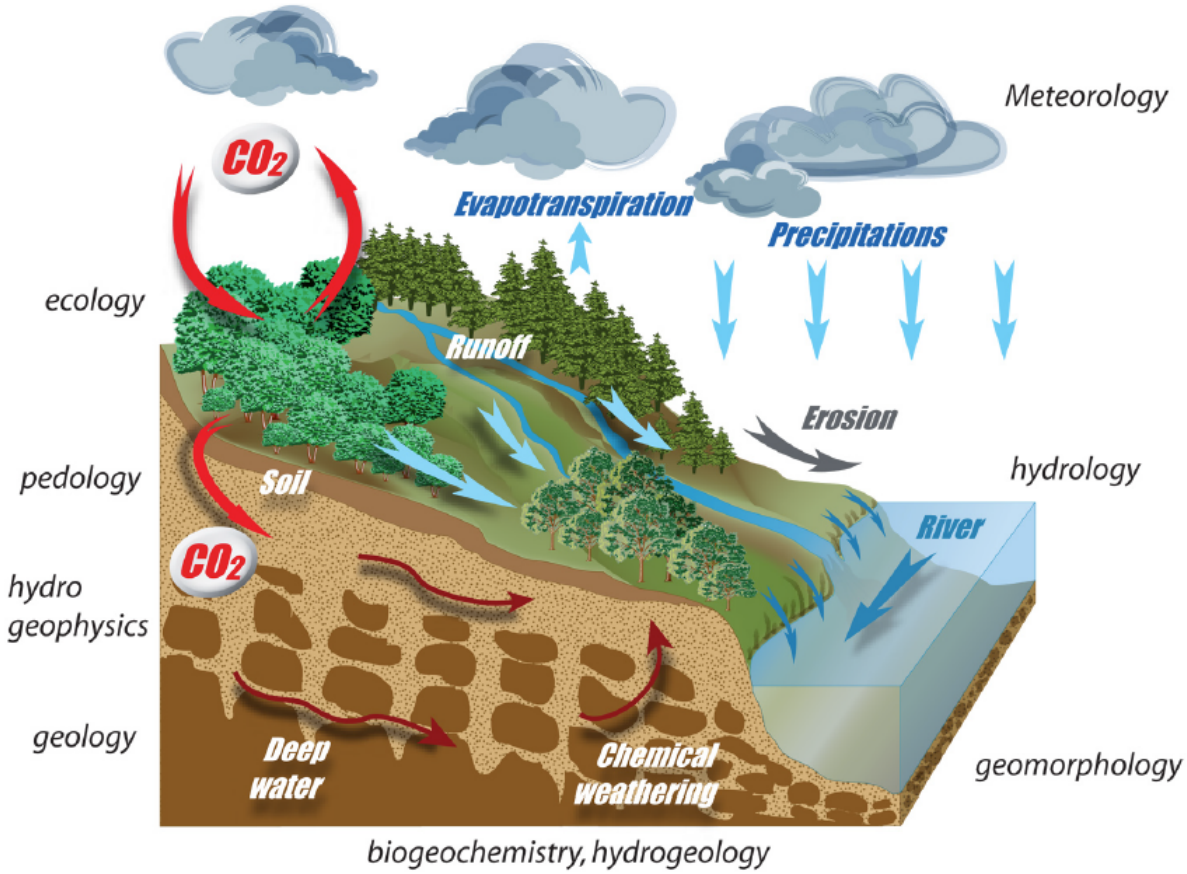
Under human and climatic pressure





Overarching questions

Water, matter and energy budget at catchment scale, reactivity dynamics, impact of heterogeneity …



Ambition of CRITEX

Bridge the gap among scientific communities working on the Critical Zone, share techniques on given sites.

CRITEX : a common shared infrastructure

- Sharing instruments and knowledge : Shared instruments maintained by “reference” teams and applied on field sites of interest
- Two communities :
  - RBV – Network of hydrological observatories
  - H+ - Network of Hydrogeological research sites
- 21 partners, 15 Universities, 5 institutions
- Started Sept. 1, 2012.

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RBV

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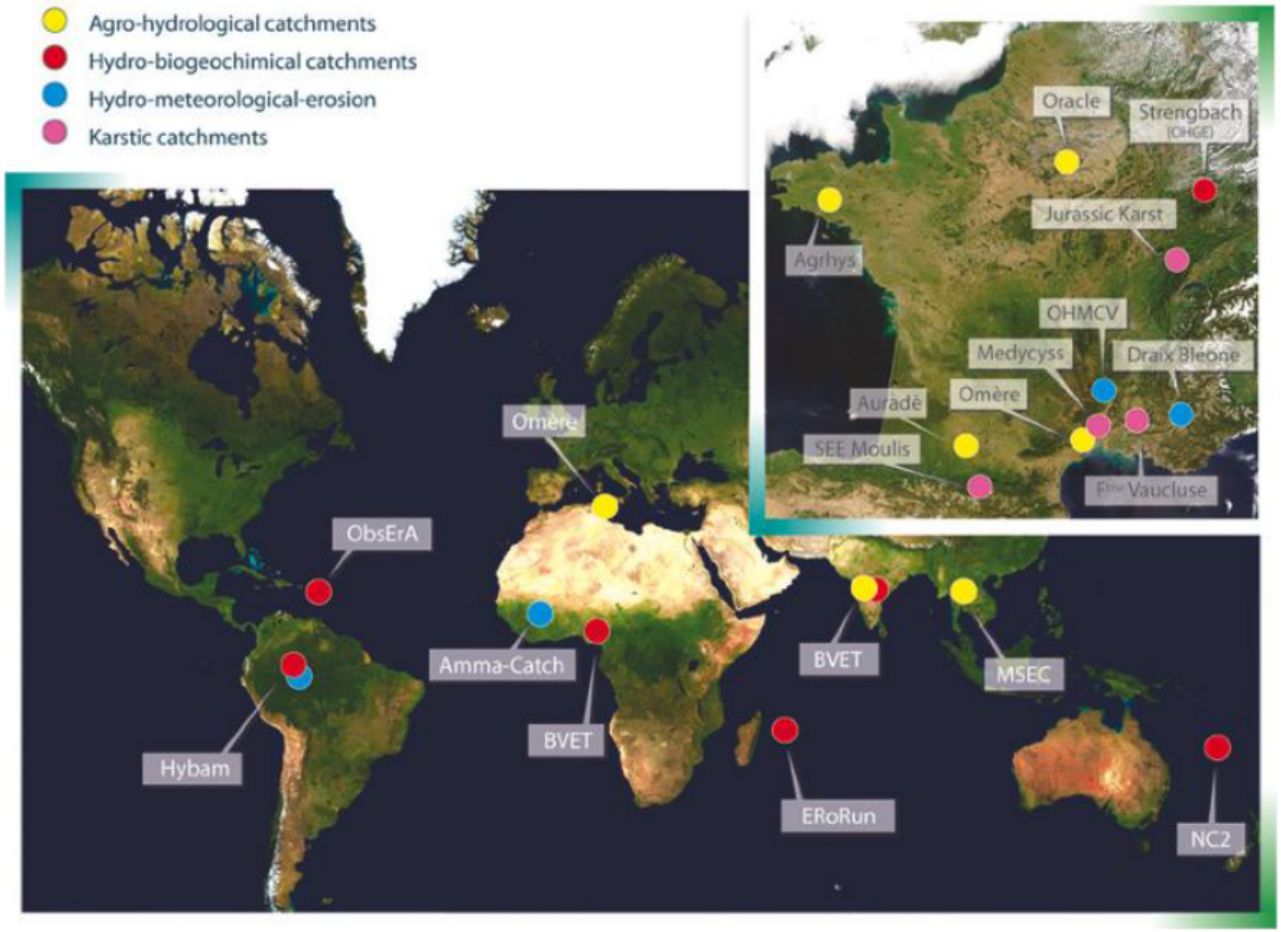


Agro-hydrological
Hydro-biogeochemical
Hydro-meteorological
Karstic

Observatories

cnrs
Institut national des sciences de l'Univers
www.insu.cnrs.fr

INRA

+ Universities

IRD
Institut de recherche pour le développement

Géosciences pour une Terre durable
brgm

irstea

PI : Jérôme Gaillardet
Co-PI : Guillaume Nord

National Observatory Service since 2002

of the National Institute for earth sciences and astronomy (INSU)

Network of Hydrogeological Research Sites

for measuring and modeling the transfer and reactivity of water flow in heterogeneous aquifers

Application to the protection, and sustainable development of groundwater resources

PI : Philippe Davy

Co-PI : Tanguy Le Borgne

Institut national des sciences de l'Univers

www.insu.cnrs.fr

Université de Rennes 1

Université Montpellier 2 Sciences et Techniques

Université d'Avignon et des Pays de Vaucluse

Université de Poitiers

Géosciences pour une Terre durable brgm

CRITEX : a shared research infrastructure

- Instruments “state of the practice”, state of the research, state of the science”.
- State of the research : prototypes of news sensors
- Mature instruments will be made available for the H+ and RBV communities and will be applied on selected field sites of interest to answer scientific question. Training will be organized to stimulate mutual interest between sites and techniques.

RÉSEAU DES BASSINS VERSANTS

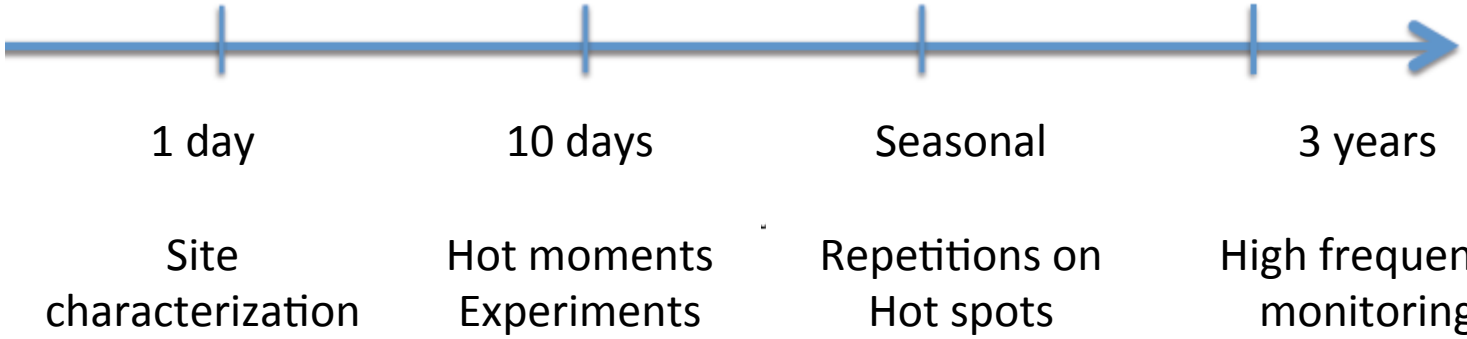
CRITEX : Two main scientific objectives

- High frequency measurements in catchments
- Monitoring campains to capture “hot moments” and “hot spots” of the saturated and non-saturated zone of the CZ in catchments from the field observatories. Include experiments and characterization

RÉSEAU DES BASSINS VERSANTS

CRITEX : organizing monitoring and experiments

- Observation strategies :
  - High frequency over 2-3 years : capturing matter and energy budget
  - Repeated measurements campaigns during « hot moments » on « hot spots » + Experiments



High frequency measurements

WP1 : soil-atmosphere exchanges

1.1 : microwave scintillometry
1.2 : flux tower ad IR scintillometry

WP2 : pulsation of water in the ZC

2.1 : hydrogravimetry
2.2 : hydrogeodesy
2.3 : water sensors

WP3 : temperature monitoring

Fiber optic for temperature and gas

WP4 : High temporal monitoring

4.1 : extreme event monitoring
4.2 : the chemical house
4.3 : innovative chemical sensors

Sequential monitoring

WP5 : Scanning the surface

image drone exploration

WP6 : geophysical tools of exploration

6.1 : seismic methods
6.2 : MSR
6.3 : electrical methods
6.4 : polarization
6.5 : CS-AMT

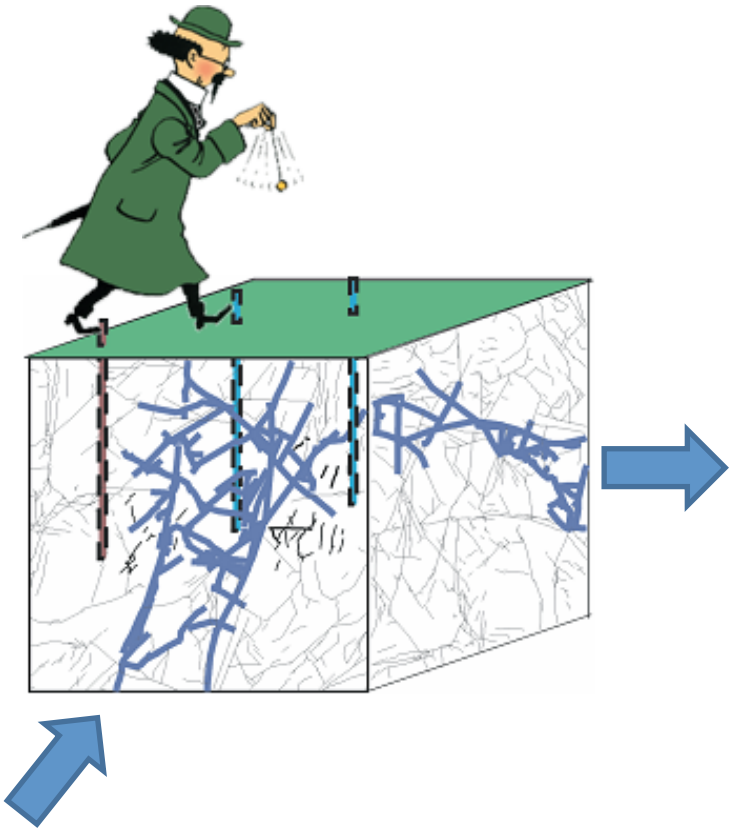
WP7 : inacessible groundwaters

7.1 : well equipement
7.2 : well monitoring
7.3 : reactive and inert tracer test experiments

WP8 : chemical and isotopic fingerprints

8.1 : gas tracing
8.2 : water isotopes
8.3 : integrative sensors

Task 2.2 – Hydrogeodesy, the pathways of water



Main idea:

Subsurface permeable structures concentrate water flow and pressure changes, i.e. induce specific surface poroelastic deformation

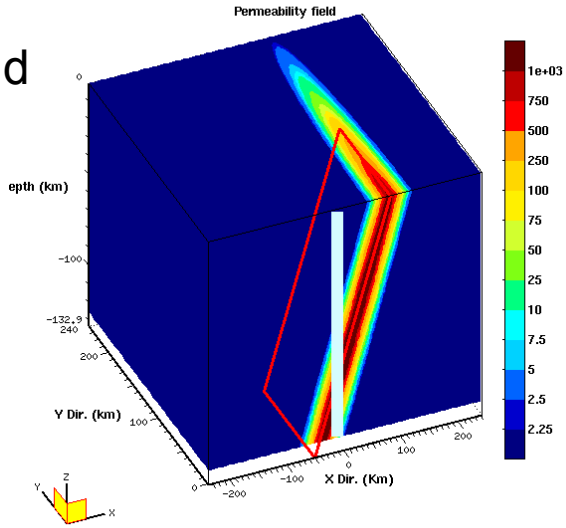
Observation tools to develop :

- Tiltmeters
- Vertical deformation

Task leader : Laurent Longuevergne, géosciences Rennes.

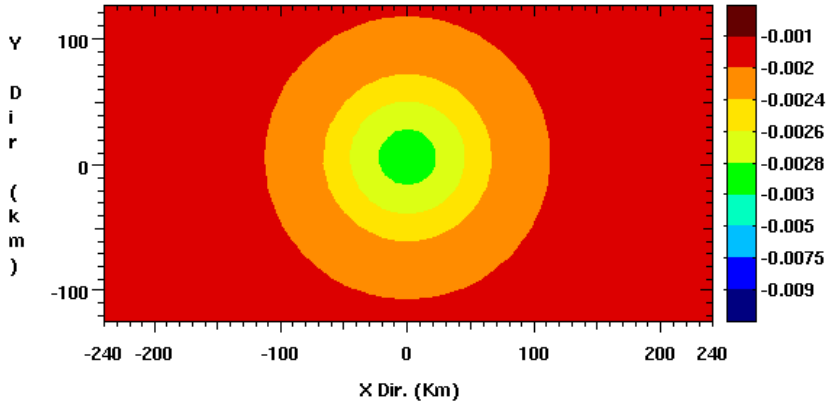
Task 2.2 – Hydrogeodesy, the pathways of water

Permeability field

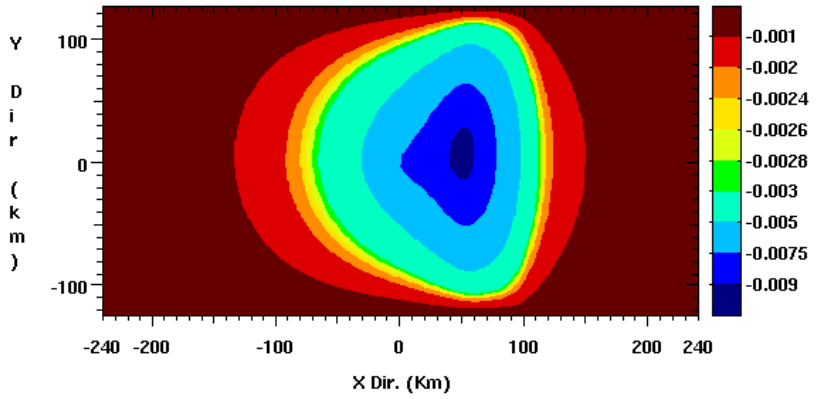


Modeling example:
Surface deformation induced by pumping

Homegeneous media

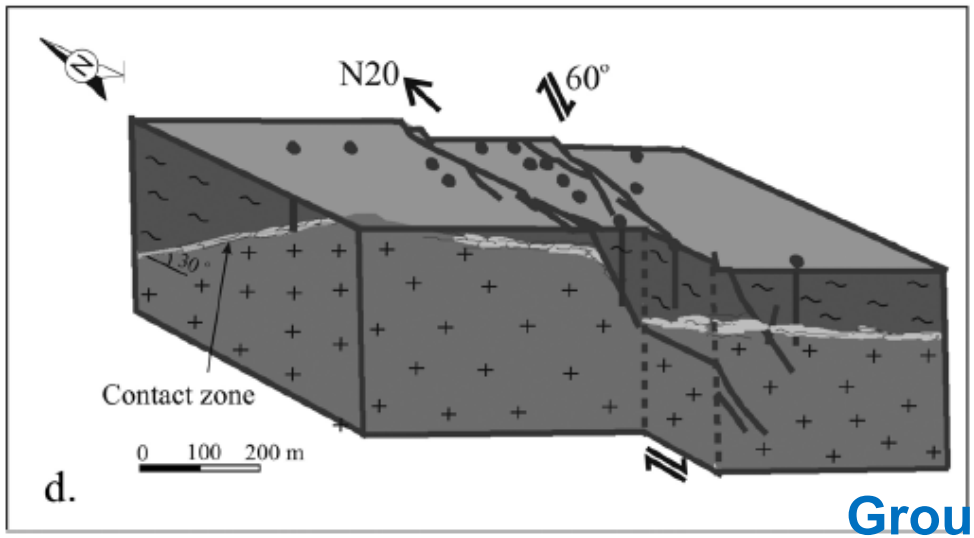


Heterogeneous media



Heterogeneity is an opportunity as it amplifies surface deformation and creates specific surface patterns

Task 2.2 – Hydrogeodesy, the pathways of water



Case of Ploemeur observatory

High yield pumping station in crystalline context

Ground surface elevation changes (mm)

Surface deformation highlights active parts of the main permeable fractures.

Estimation of storativity 3.10^{-4}

Task 4.2: The River Chemical House: RICH

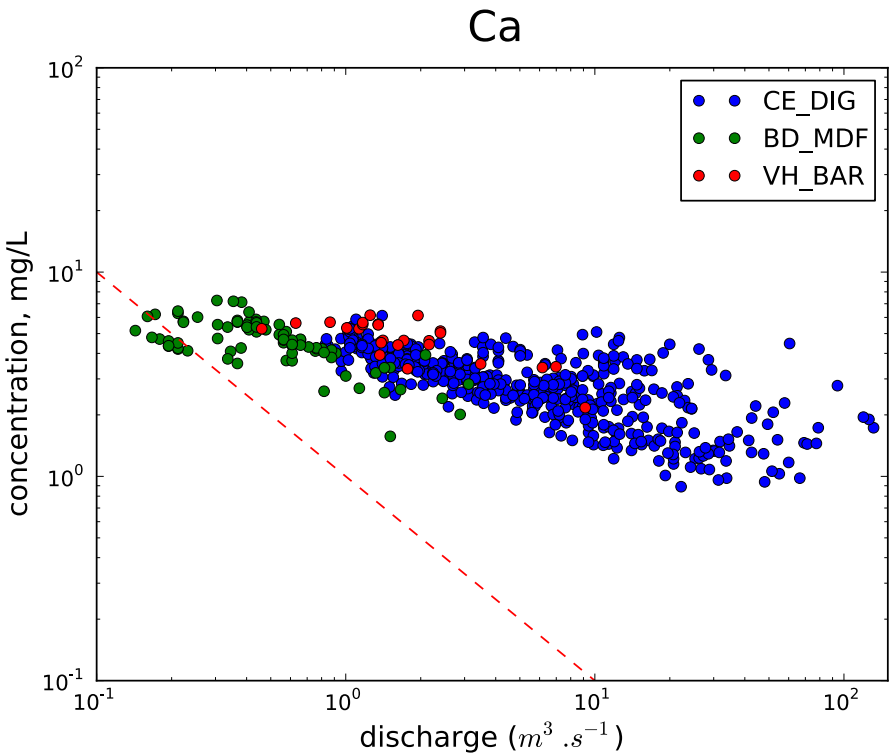
Real time monitoring of river quality

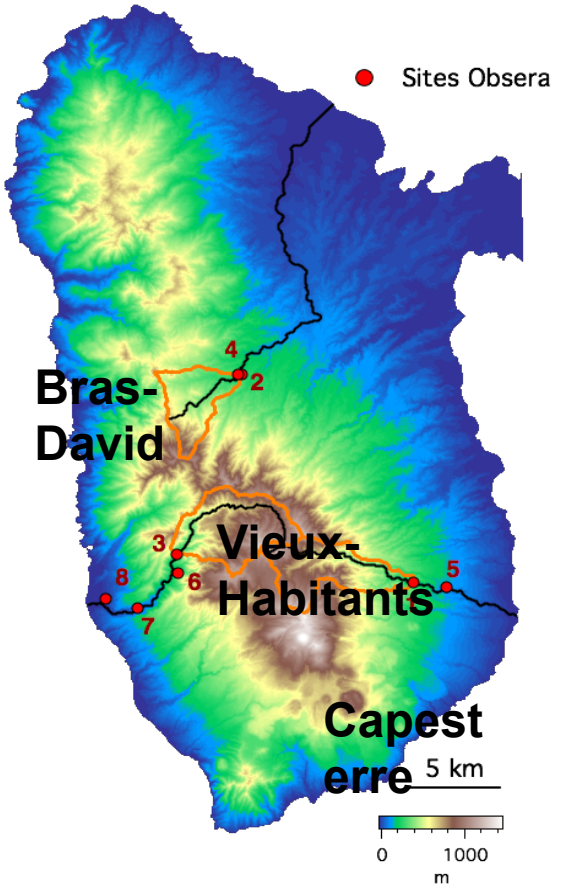
- Setting up a “house” for the real time & high----frequency monitoring of stream water chemistry with multiparametric sensors (major elements, silica, DOC, alkalinity probe under development).
- Endress-Hauser and Thermofisher companies.

- 4 analyses par hour

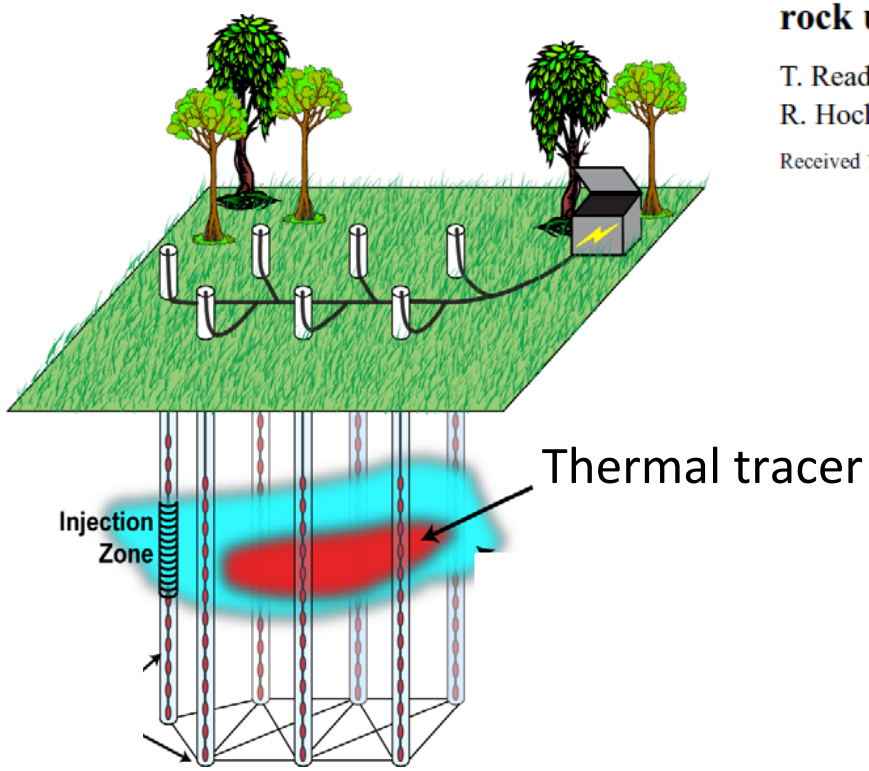
Task leader : Jérôme Gaillardet, Gaëlle Tallec, Jean Louis Roubaty, IPGP, IRSTEA Antony.

Chemostatic behavior of streams





Task 4.2 : Fiber optic monitoring of heat tracer tests to characterize preferential flow in fractured media



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Characterizing groundwater flow and heat transport in fractured rock using fiber-optic distributed temperature sensing

T. Read,[1] O. Bour,[2] V. Bense,[1] T. Le Borgne,[2] P. Goderniaux,[2,3] M.V. Klepikova,[2] R. Hochreutener,[2] N. Lavenant,[2] and V. Boschero[2]

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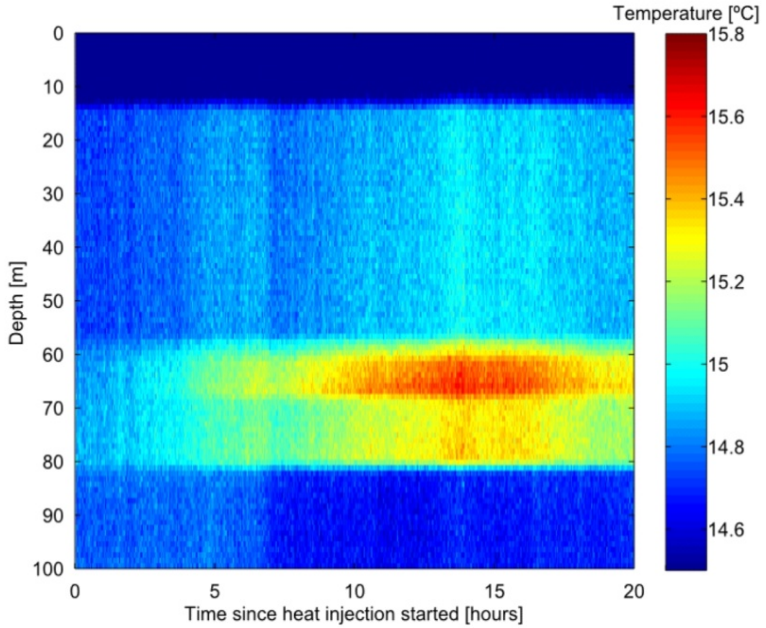
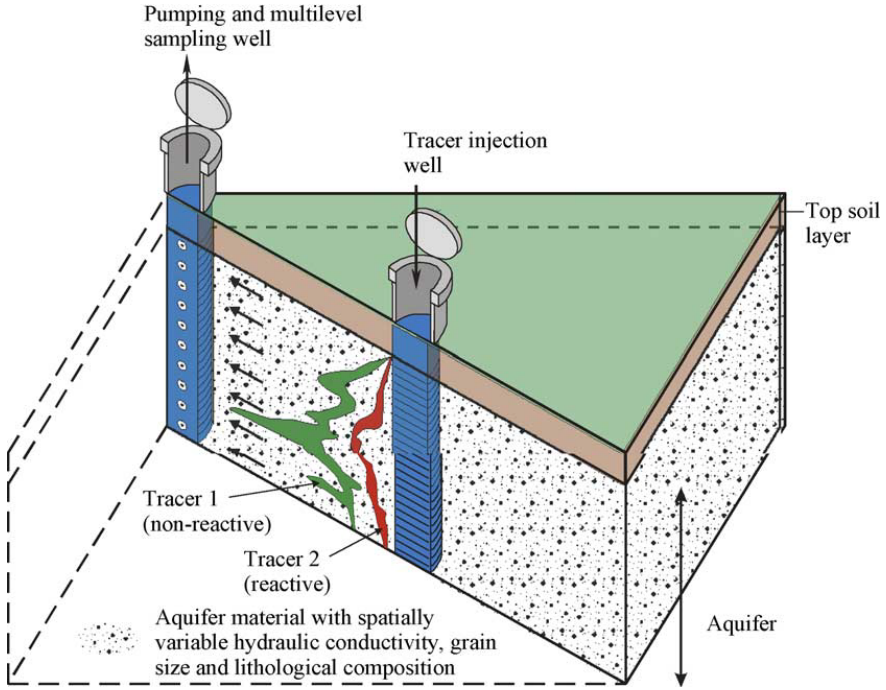


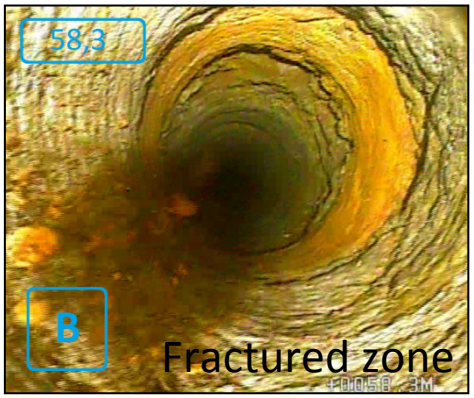
Task leader : T. Le Borgne, géosciences Rennes.

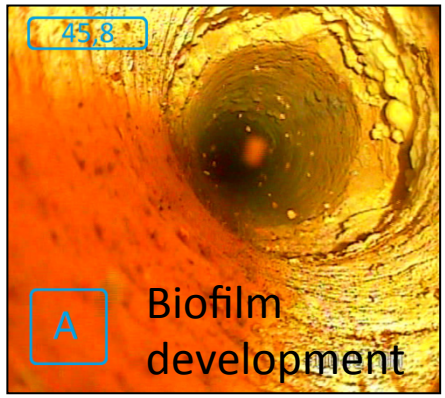
Task. 7.3: Reactive tracer tests for in situ assessment of reaction rates in the critical zone

Controlled injection system

Tracer experiments on the Ploemeur observatory







Mixing induced microbiological activity ?

Task. 7.3: Reactive tracer tests for in situ assessment of reaction rates in the critical zone

Mobile laboratory equipped for monitoring chemical species and microbiological properties in continuous fluxes during tracer experiments

CRITEX Mobile chemical laboratory

Task leader : T. Le Borgne, géosciences Rennes.

Task. 8.1: Continuous measurement of dissolved gases

Task leader : Luc Aquilina, géosciences Rennes.

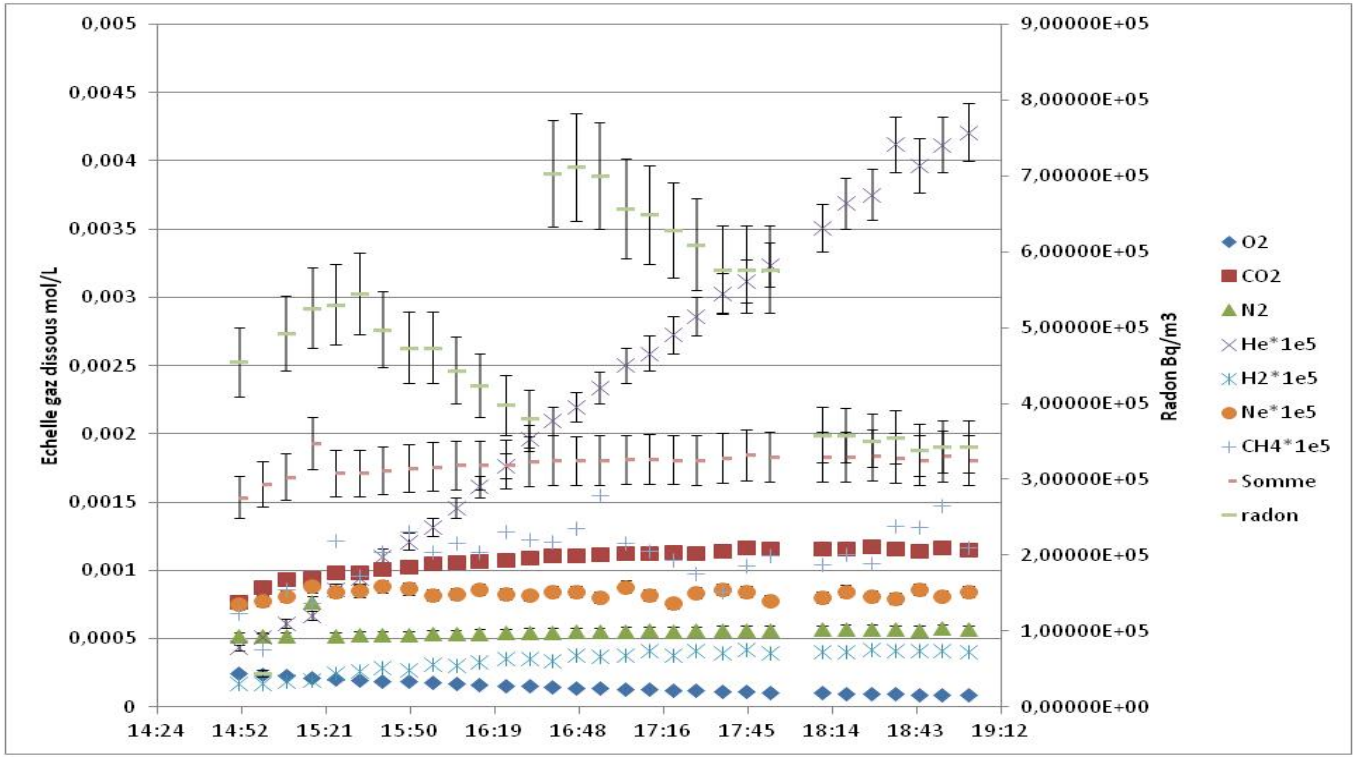
Acquisition of Radon analyzer, Menbrane Inlet mass spectrometer (MIMs) and field µGas-Chromatograph (µGC) for continuous dissolved gases charaterization

µGC for dissolved gas measurements

MIMs for dissolved Gas characterization (1 measure/5s!!)

Task. 8.1: Continuous measurement of dissolved gases

First measurements of dissolved gases during tracer tests in Ploemeur observatory (June 2014)



1 measurement every 5 min

Conclusions

A set of innovative instruments or of mature instruments used in a synergic innovative manner.

An opportunity to bridge the gap between communities of scientists studying the Critical Zone of the Earth

We need to develop new sensors of the Critical zone : this is becoming really urgent

The HF is not a EU Water Framework Directive requirement but will be soon

CRITEX is not the property of RBV and H+ network, it is open to the worldwide community and we hope it will foster international cooperation