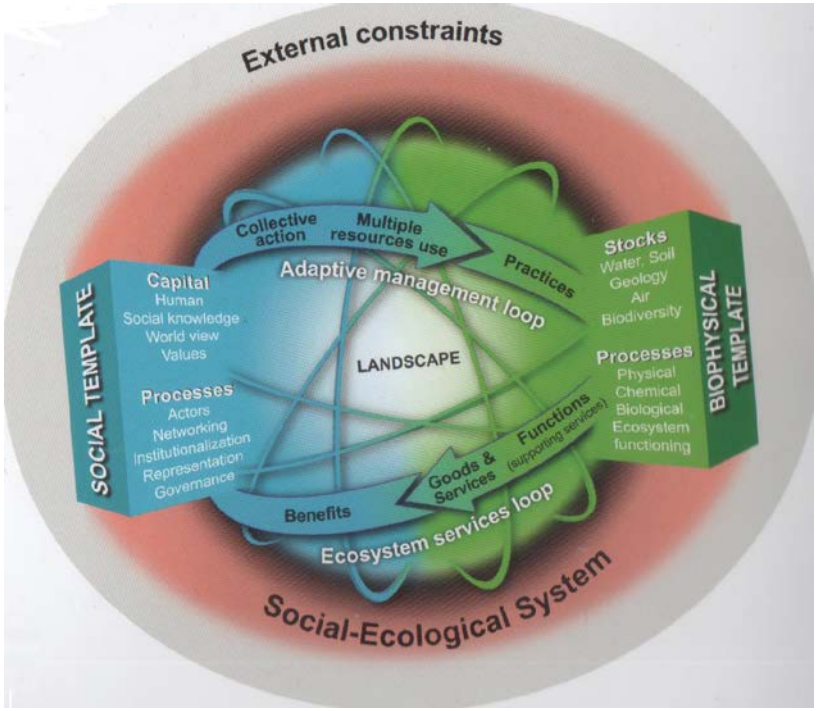
Risks and benefits of water on a uranium territory; the need to cross knowledge



ZATU started in 2015

What is a Zone Atelier (ZA)?

The Zones Ateliers form a **vast network of interdisciplinary research** in relation to societal issues
The ZAs study the **interactions between an environment and all those who** occupy and exploit it.
Long-term research programs are developed (renewal every five years on the basis of a report evaluated by the CNRS);

Some basic information

Where are we now?

Where are we going?

Some basic information

Where are we now?

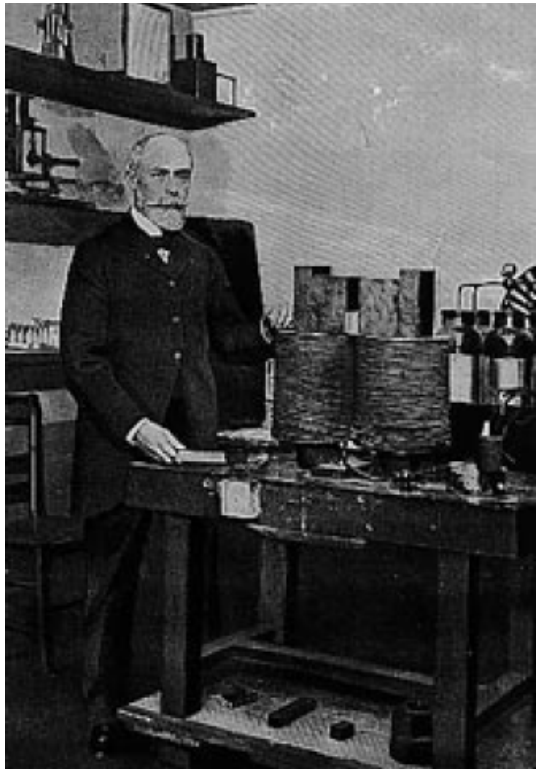
Where are we going?

Les sels d'uranium

Cet élément émet des **« rayonnements uraniques »** de manière spontanée

Pierre & Marie Curie

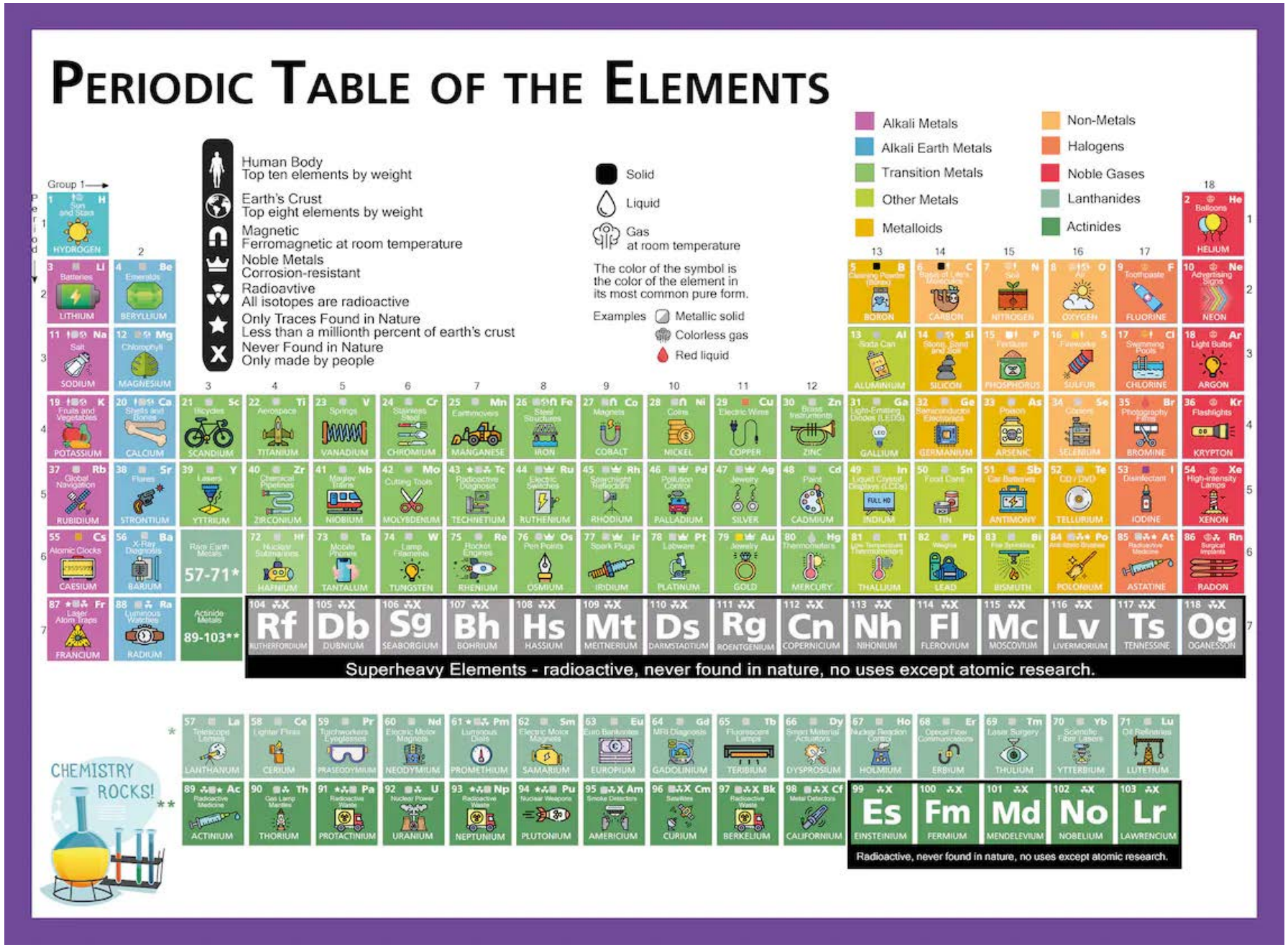
les « rayons uraniques » ne sont pas émis par le seul uranium et sont une propriété générale de la matière – le terme « radioactivité » nait

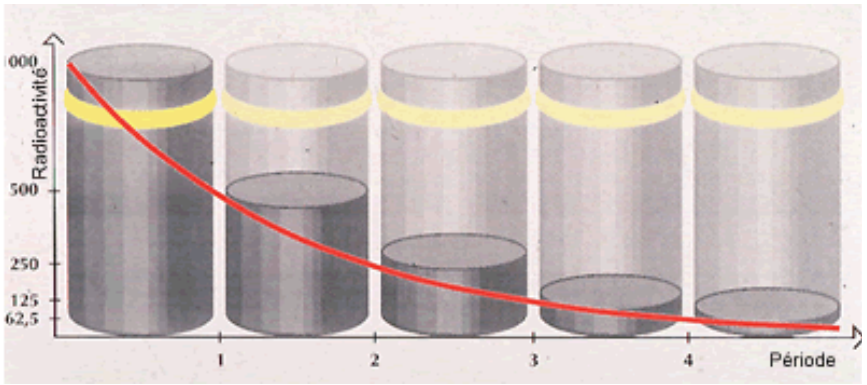


H. Béquerel

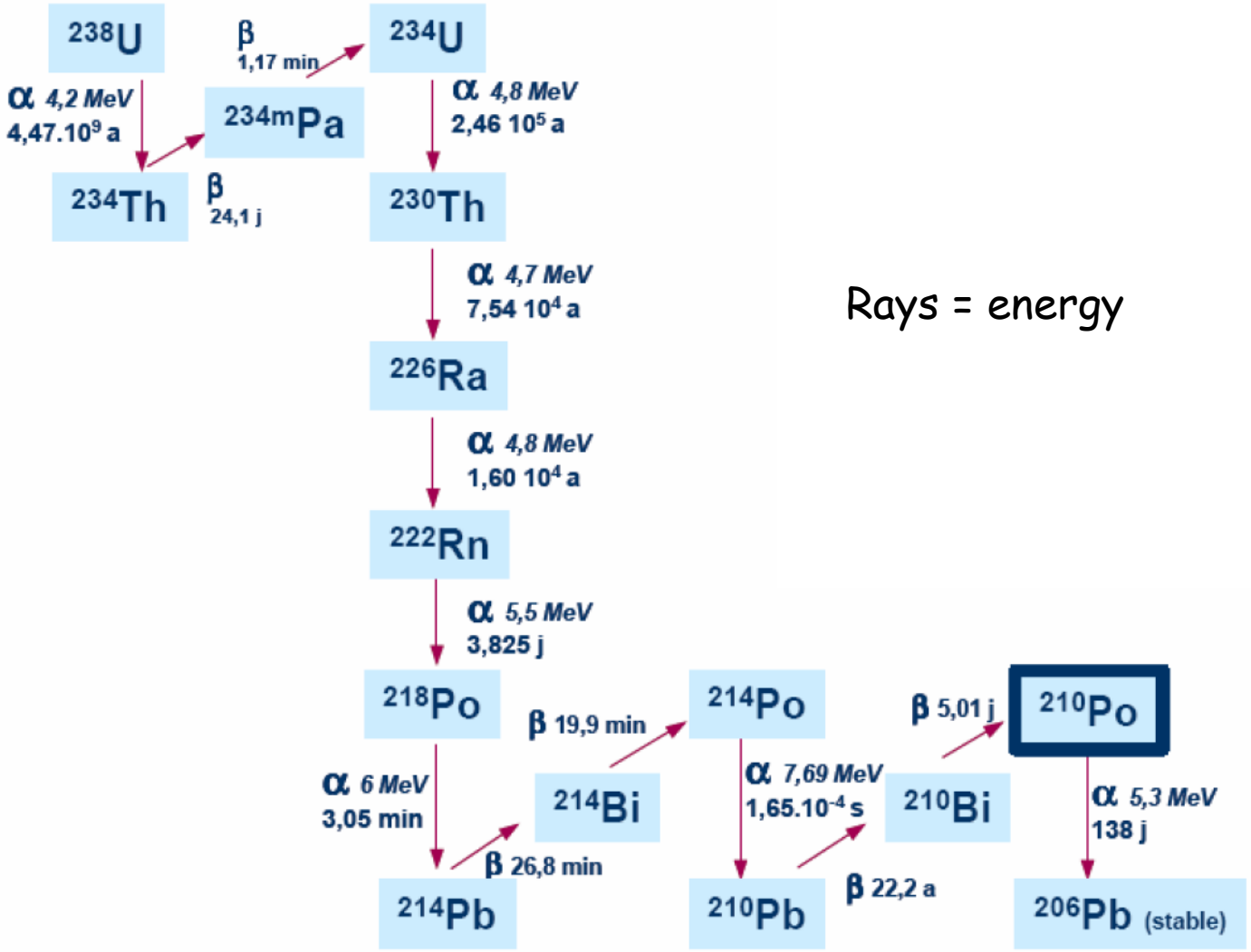
Irène & Frédéric Joliot – Curie

On peut transformer la matière et produire des isotopes radioactifs!


PERIODIC TABLE OF THE ELEMENTS
Alkali Metals
Alkali Earth Metals
Transition Metals
Other Metals
Metalloids
Non-Metals
Halogens
Noble Gases
Lanthanides
Actinides
Human Body
Top ten elements by weight
Earth's Crust
Top eight elements by weight
Magnetic
Ferromagnetic at room temperature
Noble Metals
Corrosion-resistant
Radioavtive
All isotopes are radioactive
Only Traces Found in Nature
Less than a millionth percent of earth's crust
Never Found in Nature
Only made by people
Solid
Liquid
Gas
at room temperature
The color of the symbol is the color of the element in its most common pure form.
Examples
Metallic solid
Colorless gas
Red liquid
Group 1
Period
Rare Earth Metals
57-71*
Actinide Metals
89-103**
Superheavy Elements - radioactive, never found in nature, no uses except atomic research.
Radioactive, never found in nature, no uses except atomic research.
CHEMISTRY ROCKS!



$T_{1/2}$ (U-238)= 4.5 milliards d'années



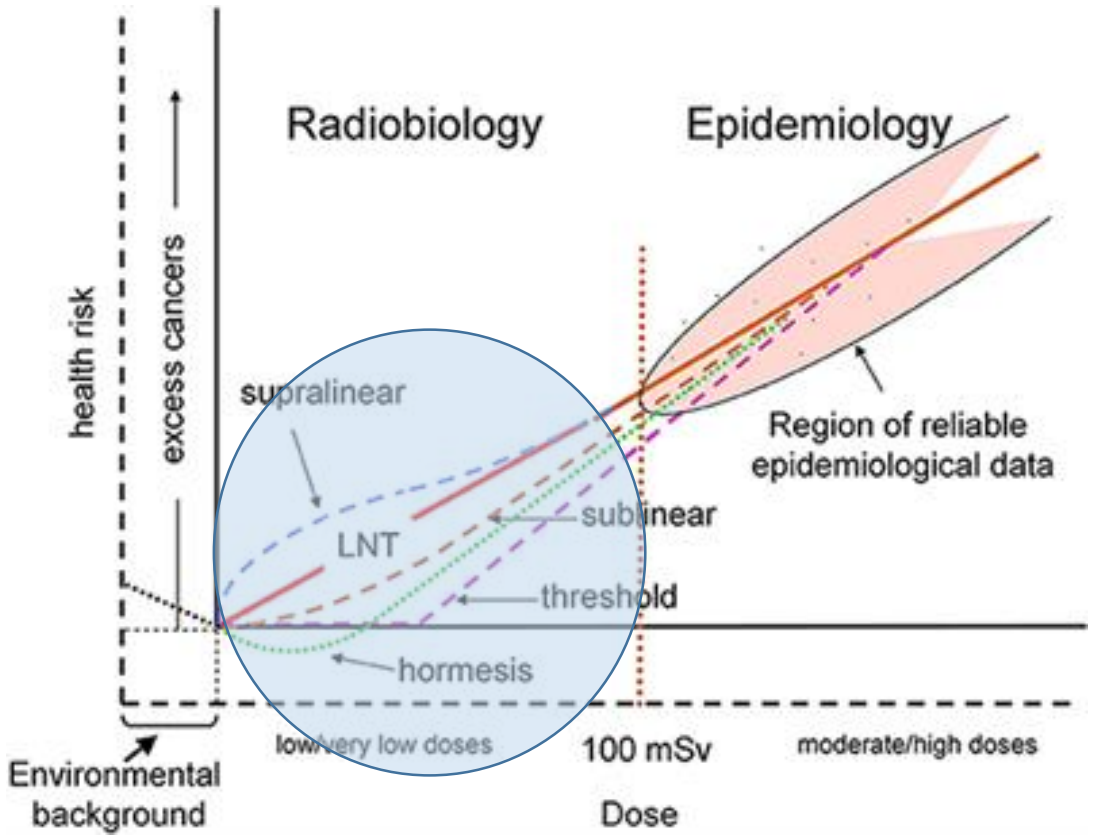
Rays = energy

Radioactivity and the origin of life?

The 1st multicellular organisms were discovered 30 km from natural nuclear reactors in Oklo (Gabon); **multicellular life already existed 2.1 billion years ago**

Notice the melted rocks from the heat of fission reaction which happen Billion years

El Albani et al, Nature 2010



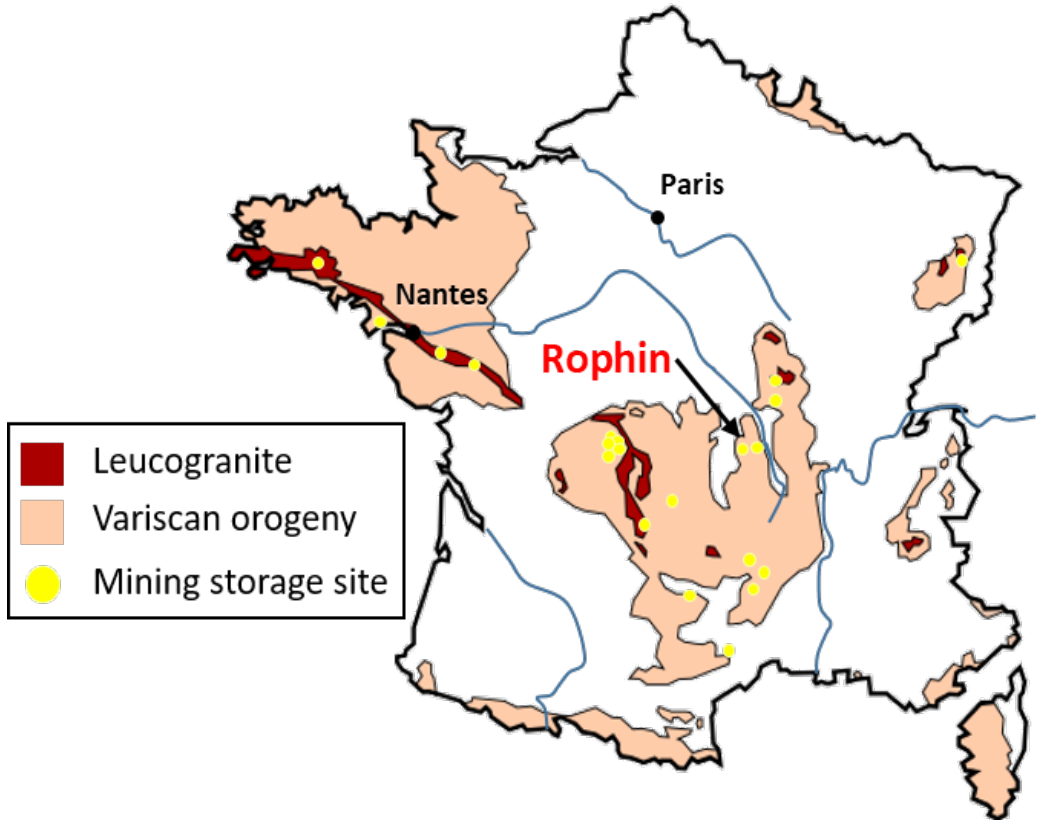
RADIATION DOSES Millisieverts (mSv)

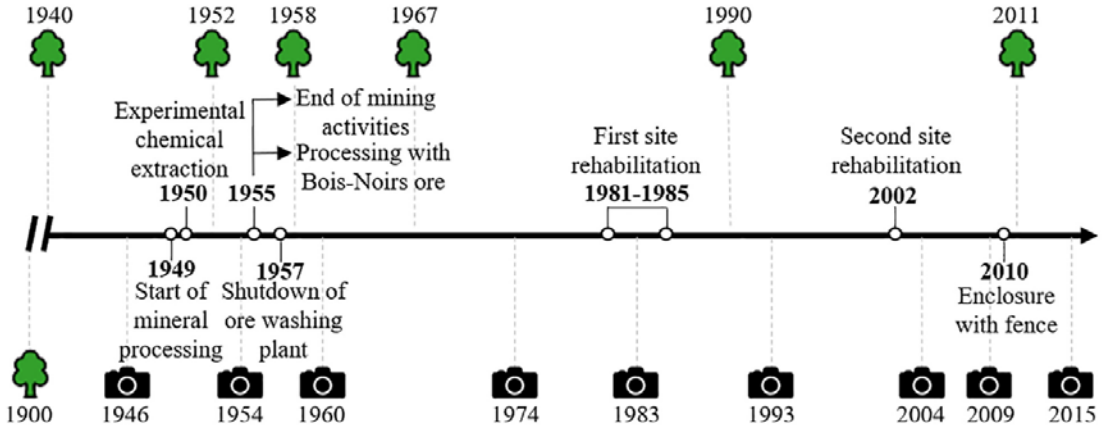
10,000	Acute radiation poisoning – death within weeks
6,000	Typical dose received by Chernobyl nuclear plant workers who died within one month of accident
3,000	Survival rate approximately 50 percent
2,200	Reading found near tanks used to store radioactive water at Fukushima plant, Sep 3, 2013
1,000	Causes radiation sickness and nausea, but not death. Likely to cause fatal cancer many years later in about 5 of every 100 persons exposed
700	Vomiting, hair loss within 2-3 weeks
500	Allowable short-term dose for emergency workers taking life-saving actions
400 per hour	Peak radiation level recorded inside Fukushima plant four days after accident
350 per lifetime	Exposure level used as criterion for relocating residents after Chernobyl accident
250	Allowable short-term dose for workers controlling 2011 Fukushima accident
100	Lowest level linked to increased cancer risk
20 per year	Average limit for nuclear industry workers
10	Full-body CT scan
2.4 per year	Person's typical exposure to background radiation
0.01	Dental x-ray

Sources: IAEA, World Nuclear Association

What is the short- and long-term risk of low-dose to humans, biodiversity and ecological services in ecosystems?

The Rophin site





- Underground exploitation: from 1948 to 1957
- Only mechanical processing
- Storage : 30000 t of mine tailings (and waste rocks)

Radioactive mineral sources

- The territories of thermalism are a socio-ecosystem where the water **conveys a " positive " signal** for the health/well-being
- The thermal water has e.g. a proven anti-inflammatory power for the digestive system (case of Chatel Guyon, Plombières les Bains);
- the role played by radioactivity in the curative power associated with thermal waters **is not known**

One century of radon therapy

Klaus Becker

Vice-President, Radiation Science & Health,
Boothstr 27, D-12207 Berlin, Germany
E-mail: prof.dr.klaus.becker@t-online.de

Abstract: Supplementing a recent review 'Health effects of high radon environments in Central Europe: another test for the HLNT hypothesis [1]', this review of medical radon applications (in particular for the treatment of painful degenerative joint and spine diseases) covers mainly the first century of large-scale use and scientific studies on this subject since the discovery of radon. Most of the studies and experiences originated in Europe, in particular Germany, Austria, and the former USSR. They have in common that they are not well known in the anglophonic scientific literature, where radon therapy is still frequently considered a placebo-type 'traditional medicine', and not be compared with the drugs such as non-steroid antirheumatics. However, based on the substantial experiences as reflected in more than one thousand papers, mostly in peer-reviewed scientific journals, on this subject, radon therapy by inhalation or baths has been established as an evidence-based effective treatment not only by empirical experience in different times and cultures, but also in randomised clinical double-blind studies. It should be further explored as an effective alternative to the use of pharmaca. Unlike radon, drugs cause serious side effects, with more than ten thousand annual casualties. The benefits in the adequate use of low-dose radon exposures far exceed the hypothetical lung cancer risk attributed to the inhalation of low radon concentrations. Further research could provide better understanding of the mechanism of the stimulating radon effects on the body's defence systems.

Keywords: radon therapy; medical radiation benefits; history of radiation effects and applications; radon balneology.

International Journal of *Molecular Sciences*

MDPI

Article

Beneficial Effects of Natural Mineral Waters on Intestinal Inflammation and the Mucosa-Associated Microbiota

Nicolas Barnich [1,*,†], Michael Rodrigues [1], Pierre Sauvanet [1,2], Caroline Chevarin [1], Sylvain Denis [3], Olivier Le Goff [3], Danielle Faure-Imbert [4], Thierry Hanh [5], Christian F Roques [6], Benoit Chassaing [7] and Monique Alric [3,†]

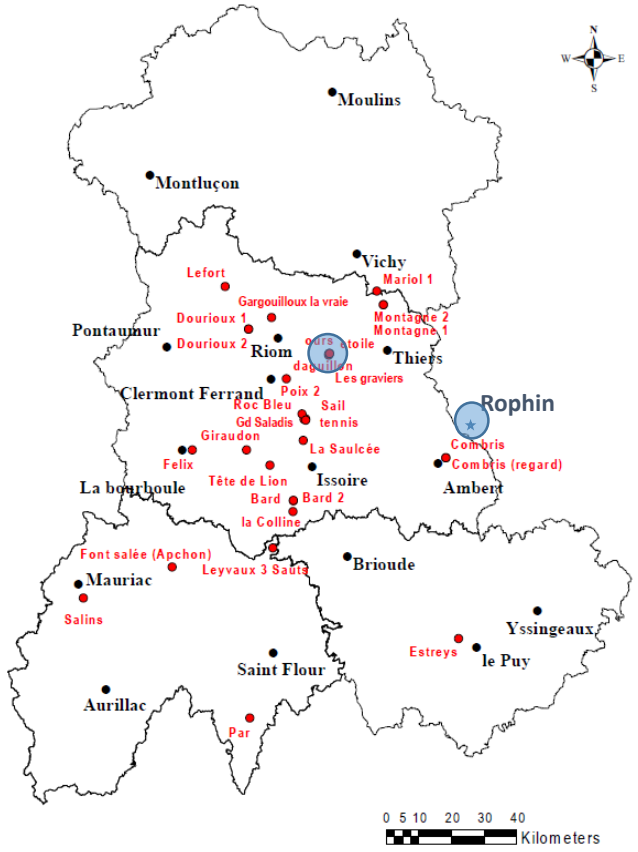
Zones Ateliers
LTSER FRANCE TERRITOIRES URANIFERES

Two complementary research axes

NOR*

These are basically non-anthropic environments

But there is a possible stress (channelization....) - how to **preserve sustainability**?



TE-NOR*

Isolated site where the vegetation grew with an history of almost 70 years!
How the environment has adapted to recent human-induced stress (**resilience**) and how can we **move towards sustainability**

*(Technology-enhanced)- naturally occurring radionuclides

Some basic information

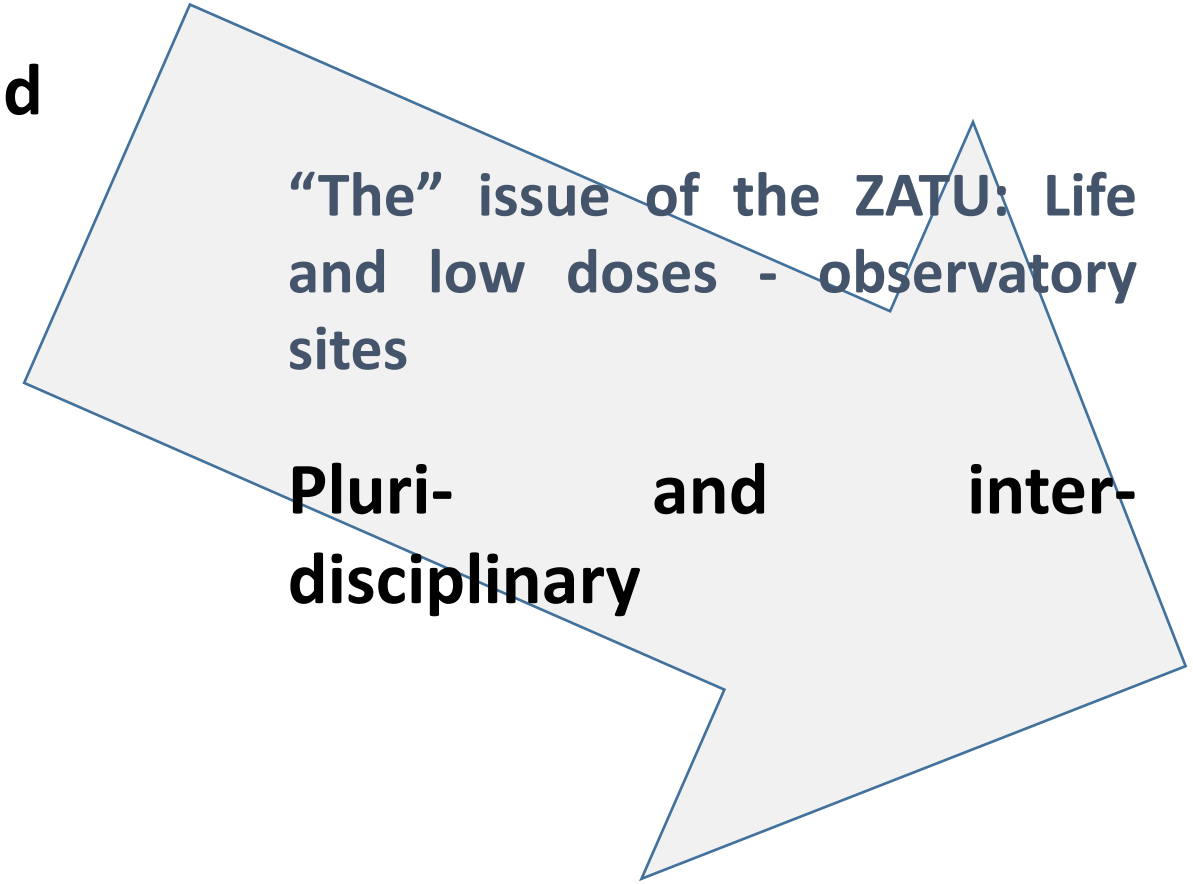
Where are we now?

Where are we going?

A long way to go!

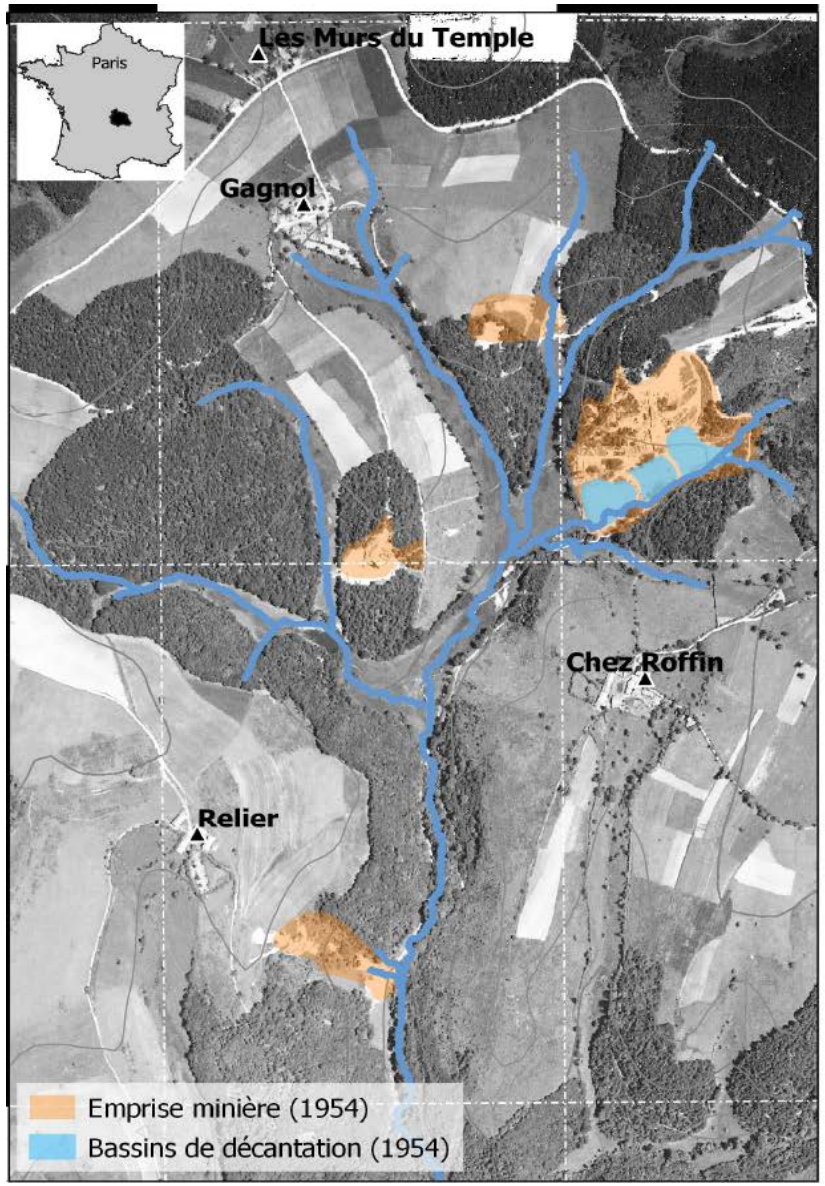
“My” scientific question

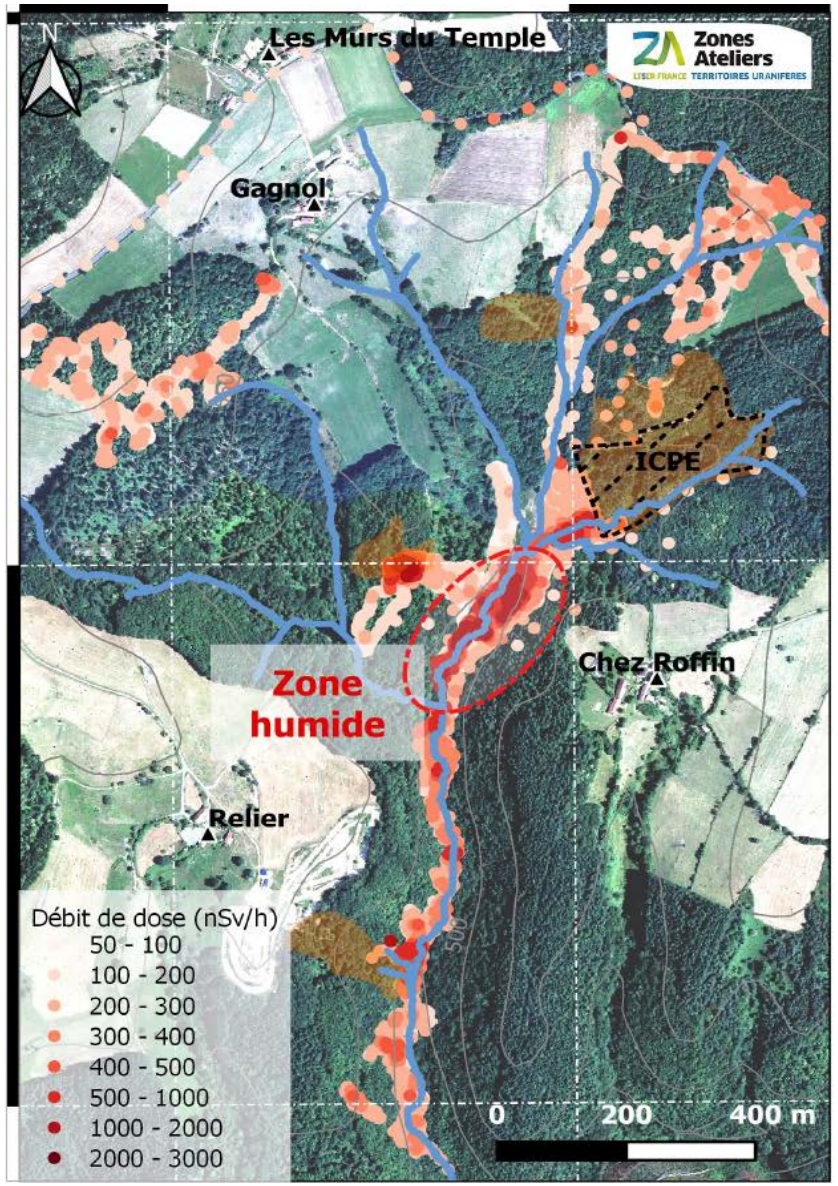
Disciplinary field



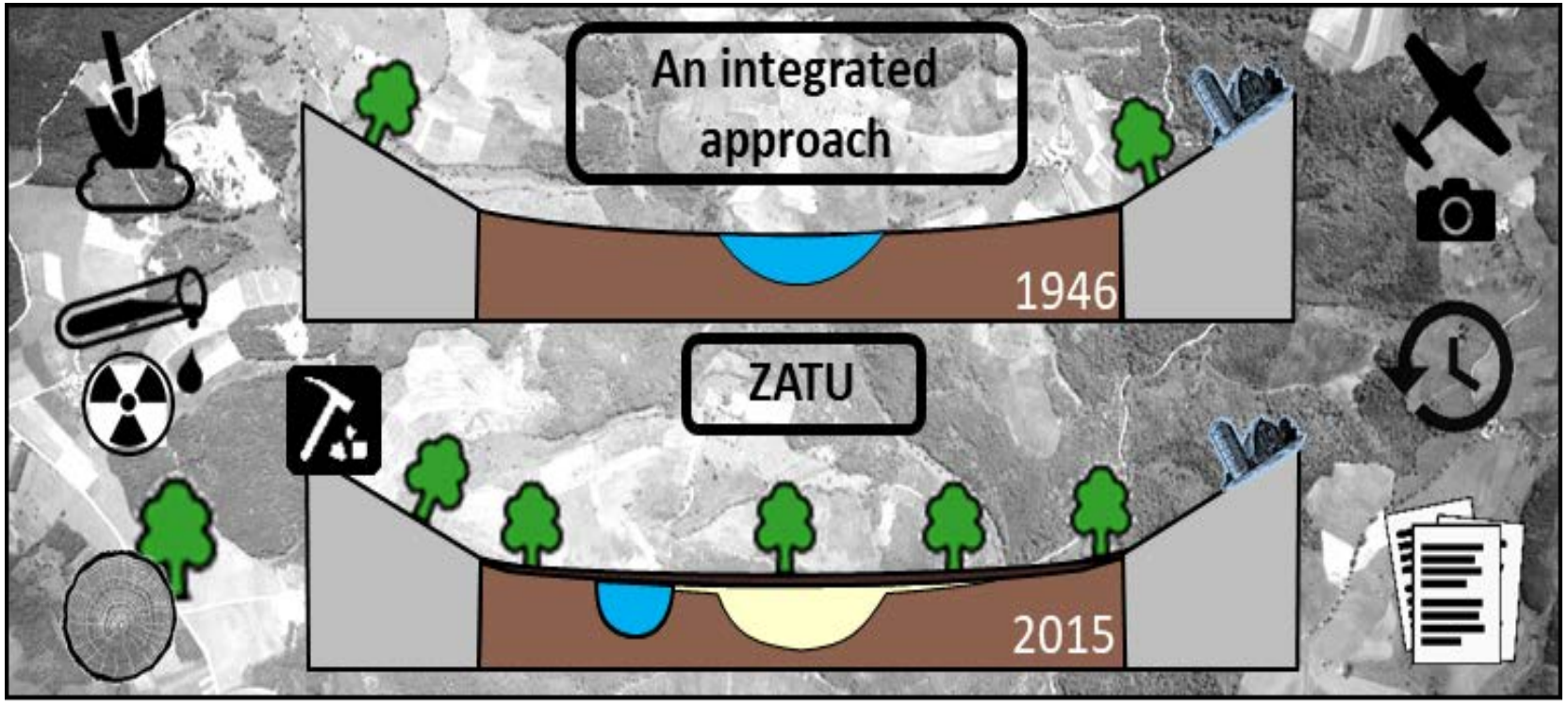
A first step, crossing the knowledge between “sciences of the matter” (physics, chemistry, biology)

The Rophin site





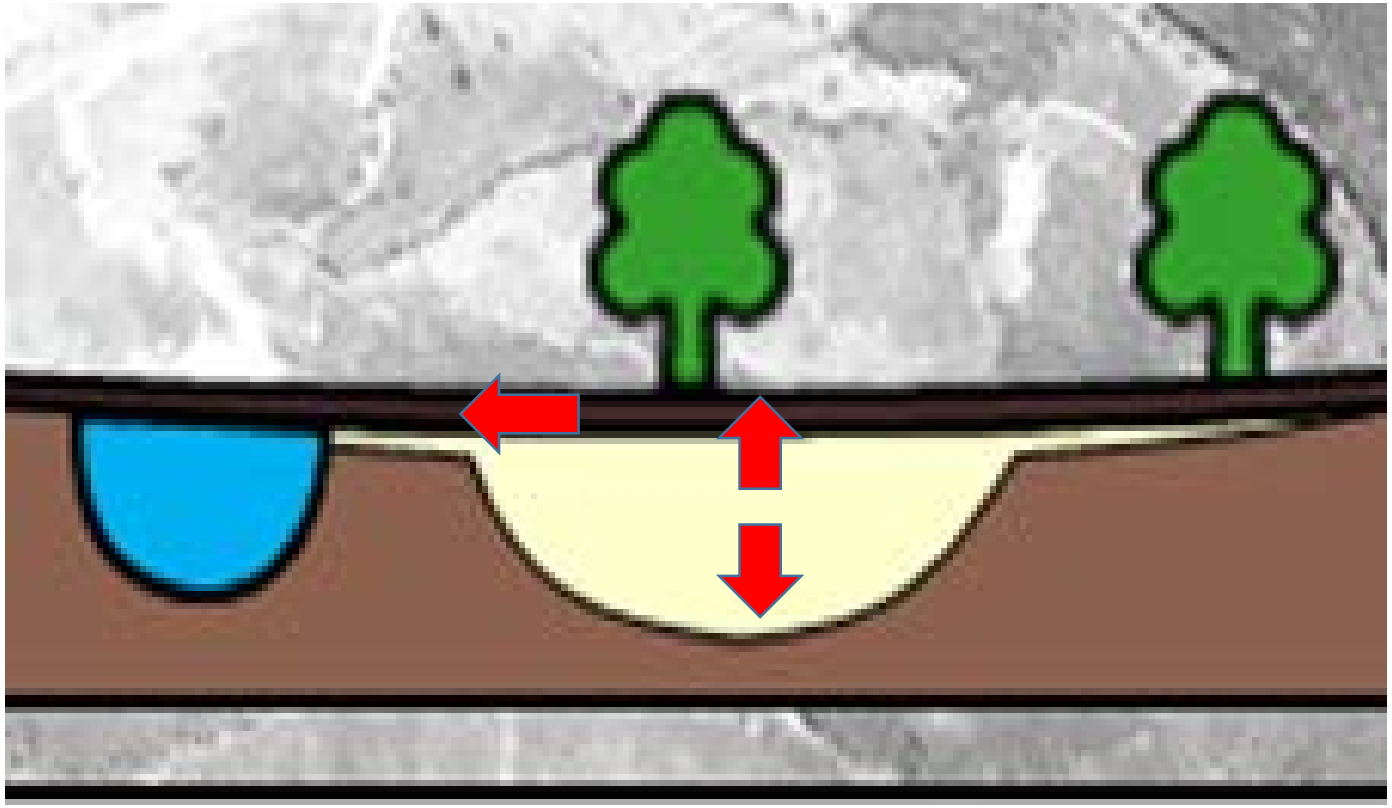
Diffuse contamination in the wetland



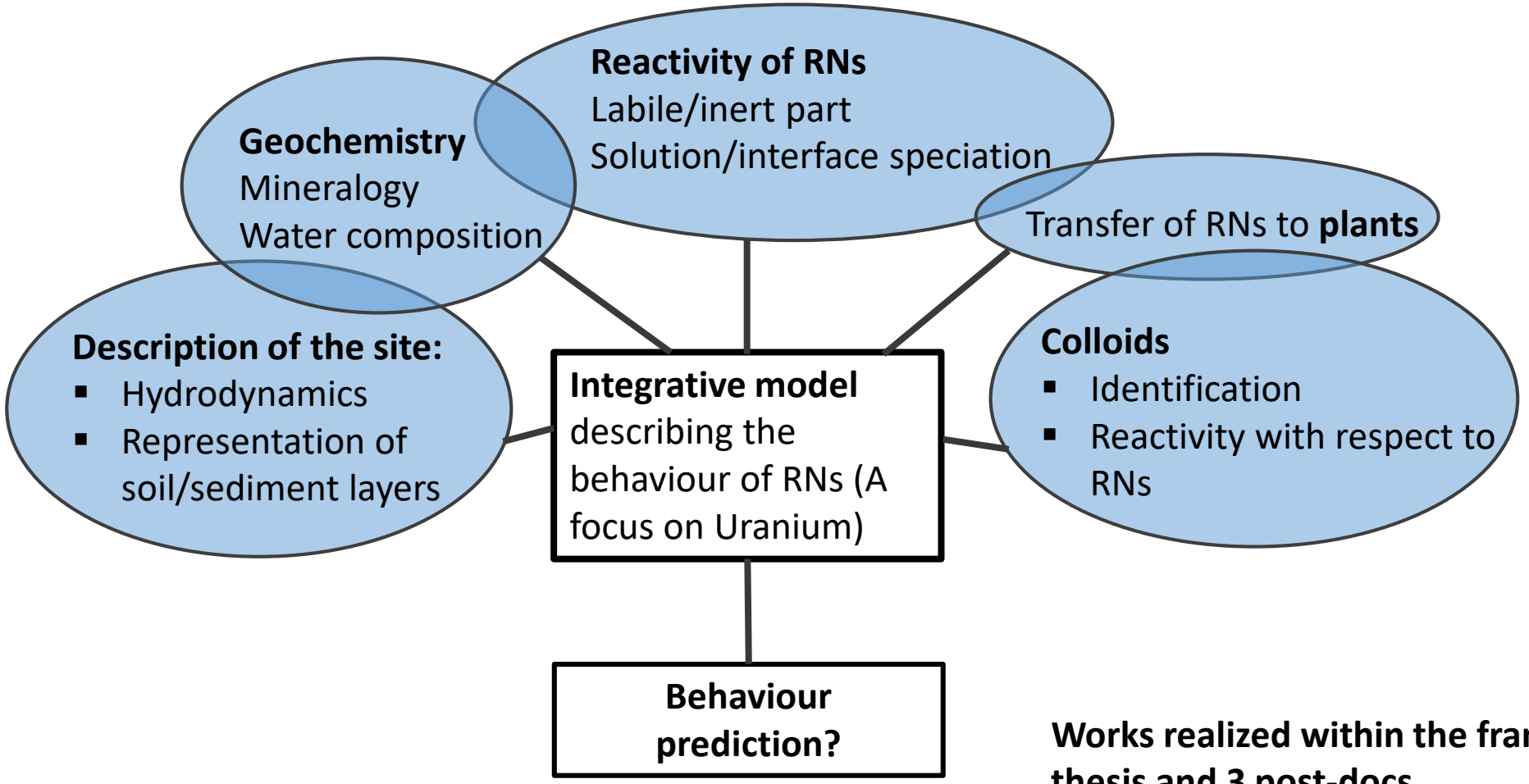
The whitish material is related to the discharge from the settling ponds at the time of mining; it is a second "source term"

Martin A. et al., ***Science of the Total Environment****, 747 (2020)*

What about the mobility of radioelements (U, Ra, Po...) and trace metals (Pb, Cu, As...)?



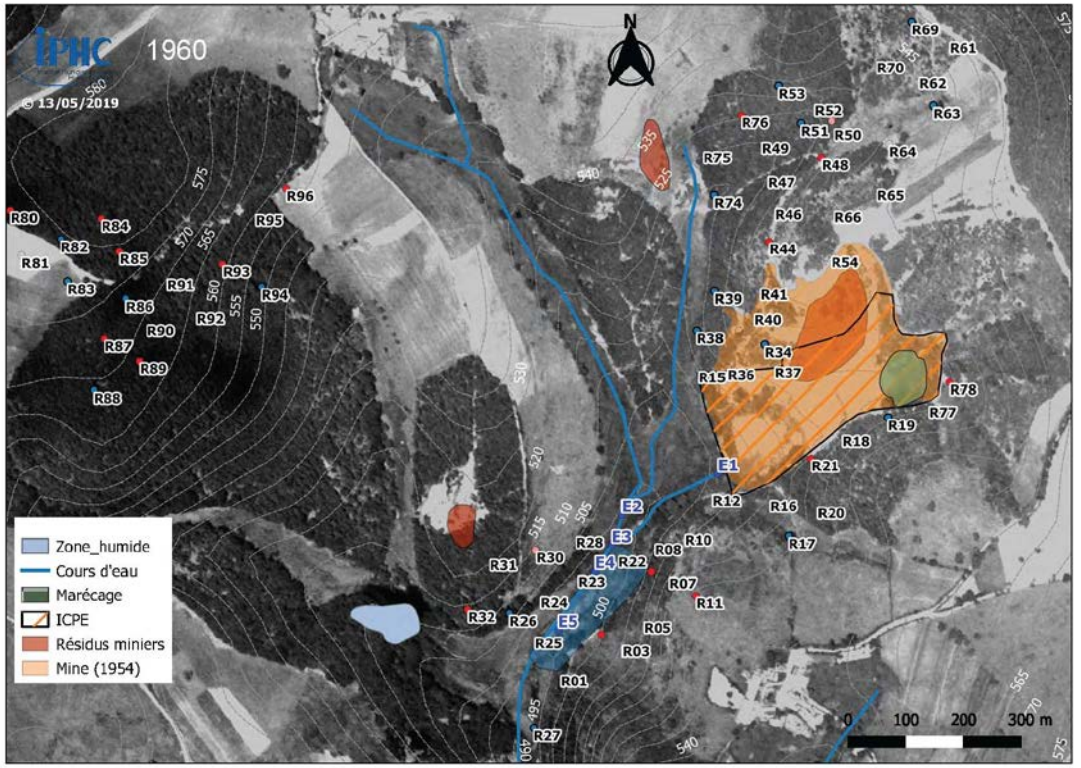
A first version of a reactive model at the wetland scale



Works realized within the framework of 4 thesis and 3 post-docs

…and the effect on living organisms?

A focus on chickadees

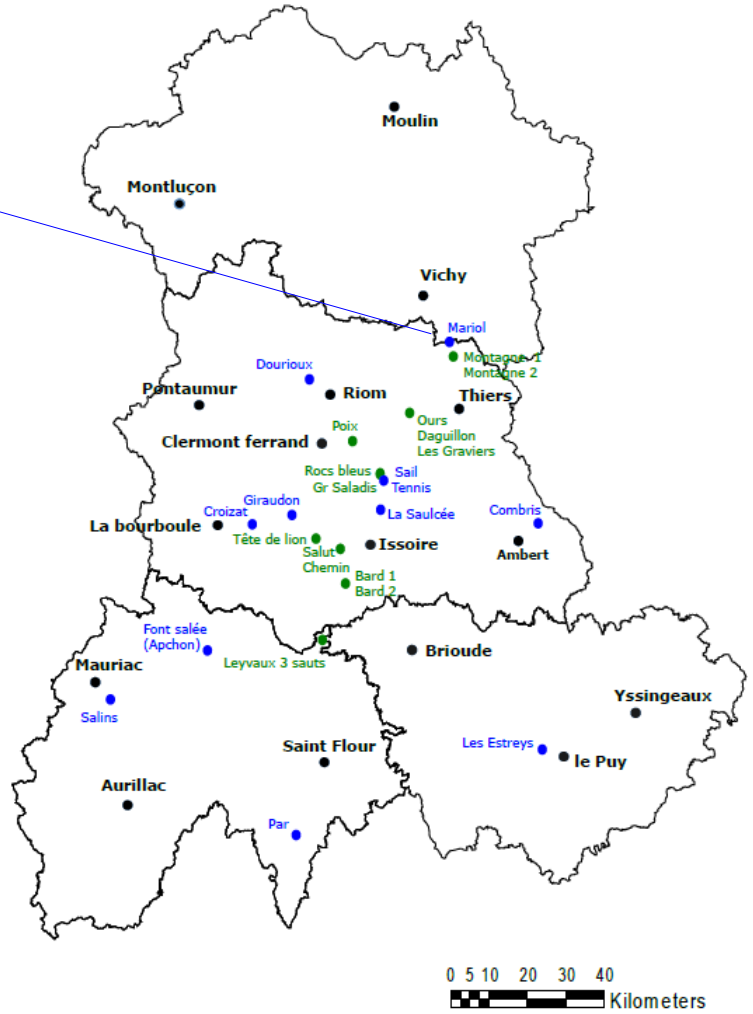


Mineral springs

32 mineral sources with variable gradients of radioactivity and different physico-chemical conditions.

Mariol

Rn activity = ~ 140 à 160 Bq/l



Montagne 1

Montagne 2

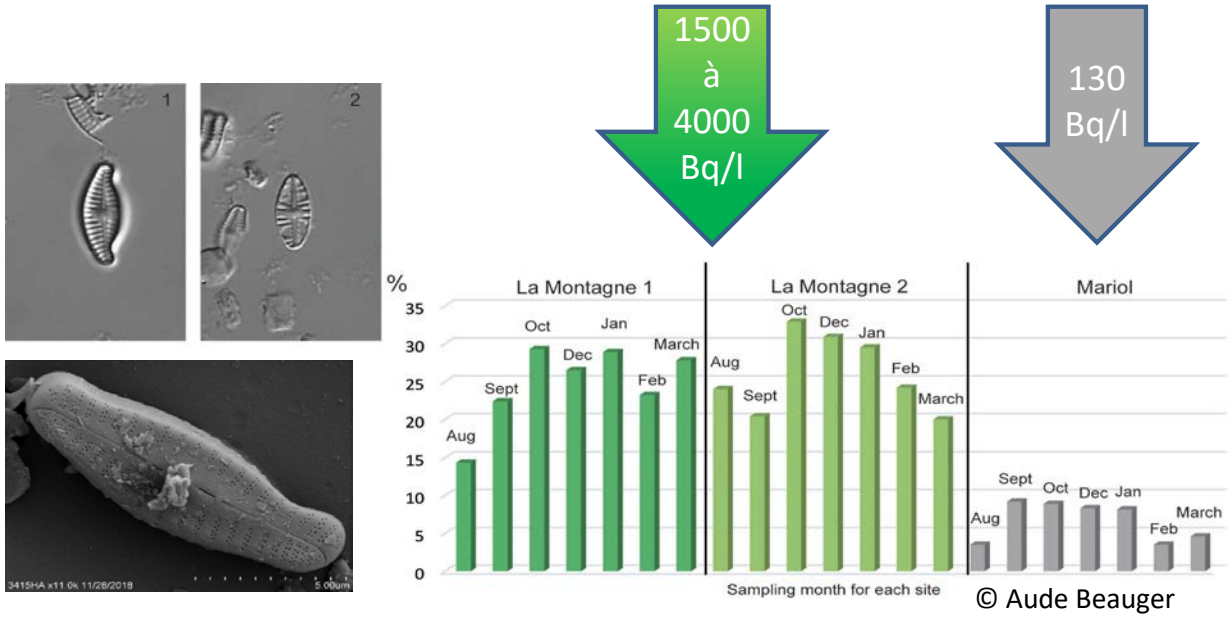
Rn activity = ~ 4000 Bq/L

Apchon

Font salée

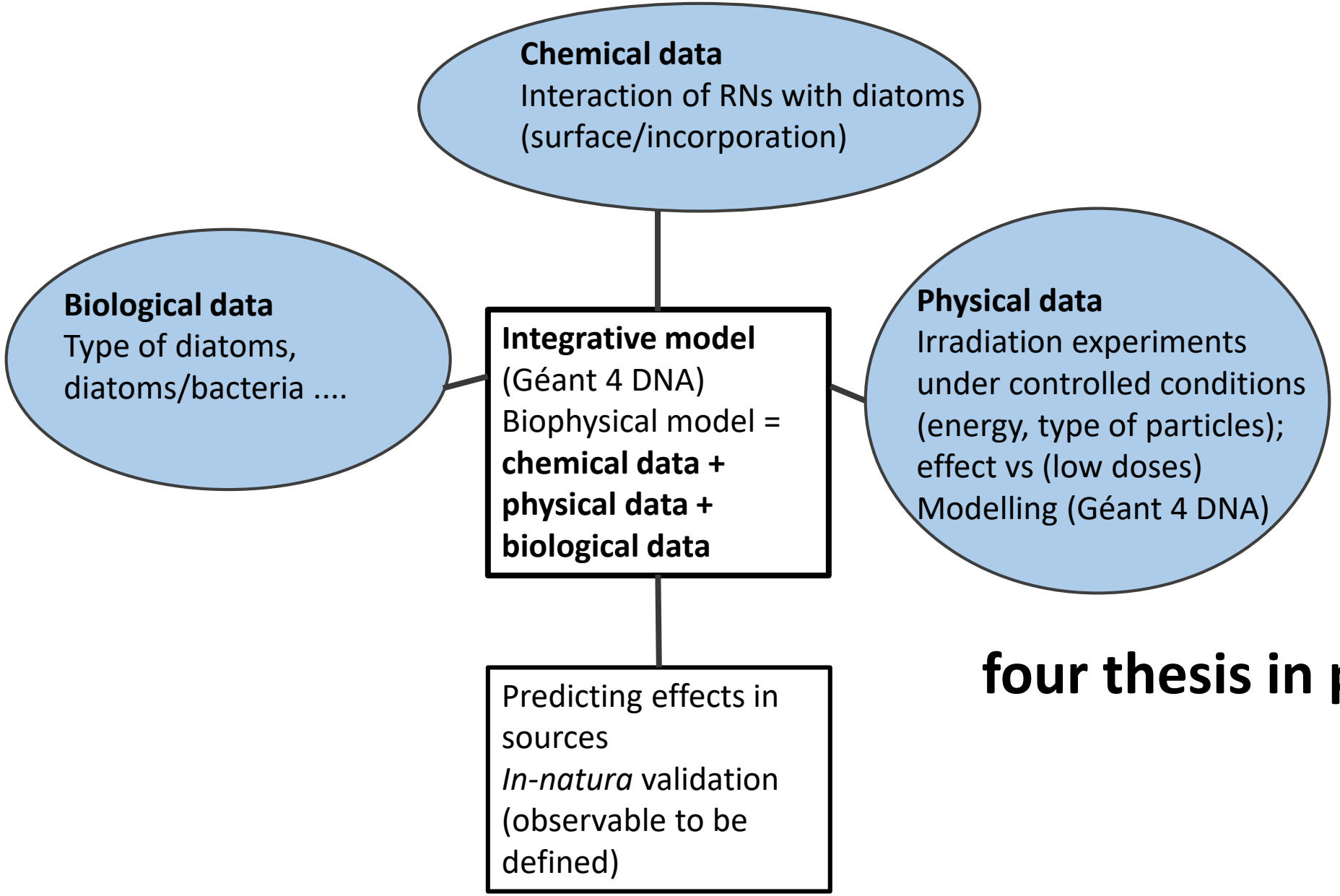
Rn activity = 9±0.5 Bq/l,

A recent result: Correlation of deformation fo diatoms with radioactivity (radon content)



© Aude Beauger

Fanny Millan et al. Botany Letters, Volume 167, 2020



four thesis in progress!

From understanding RN mobility and effects on living organisms in the environment to quantifying the exposure to RISK?

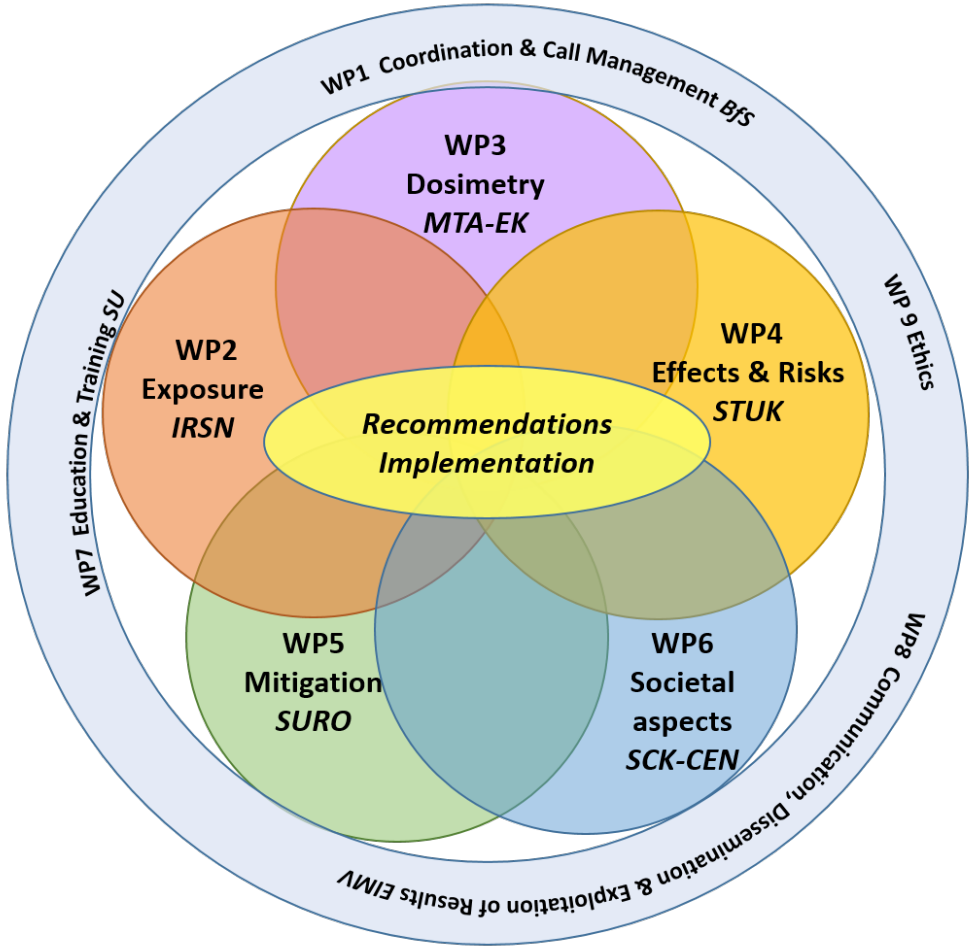
Crossing academic knowledge is not enough! We do not work on regulatory issues

Since 2019, a strong link with IRSN

RadoNorm

Managing risks from radon and NORM

Zones Ateliers
LTSER FRANCE TERRITOIRES URANIFERES



What about risk perception?

The cloud from the Techernobyl accident stopped at the border

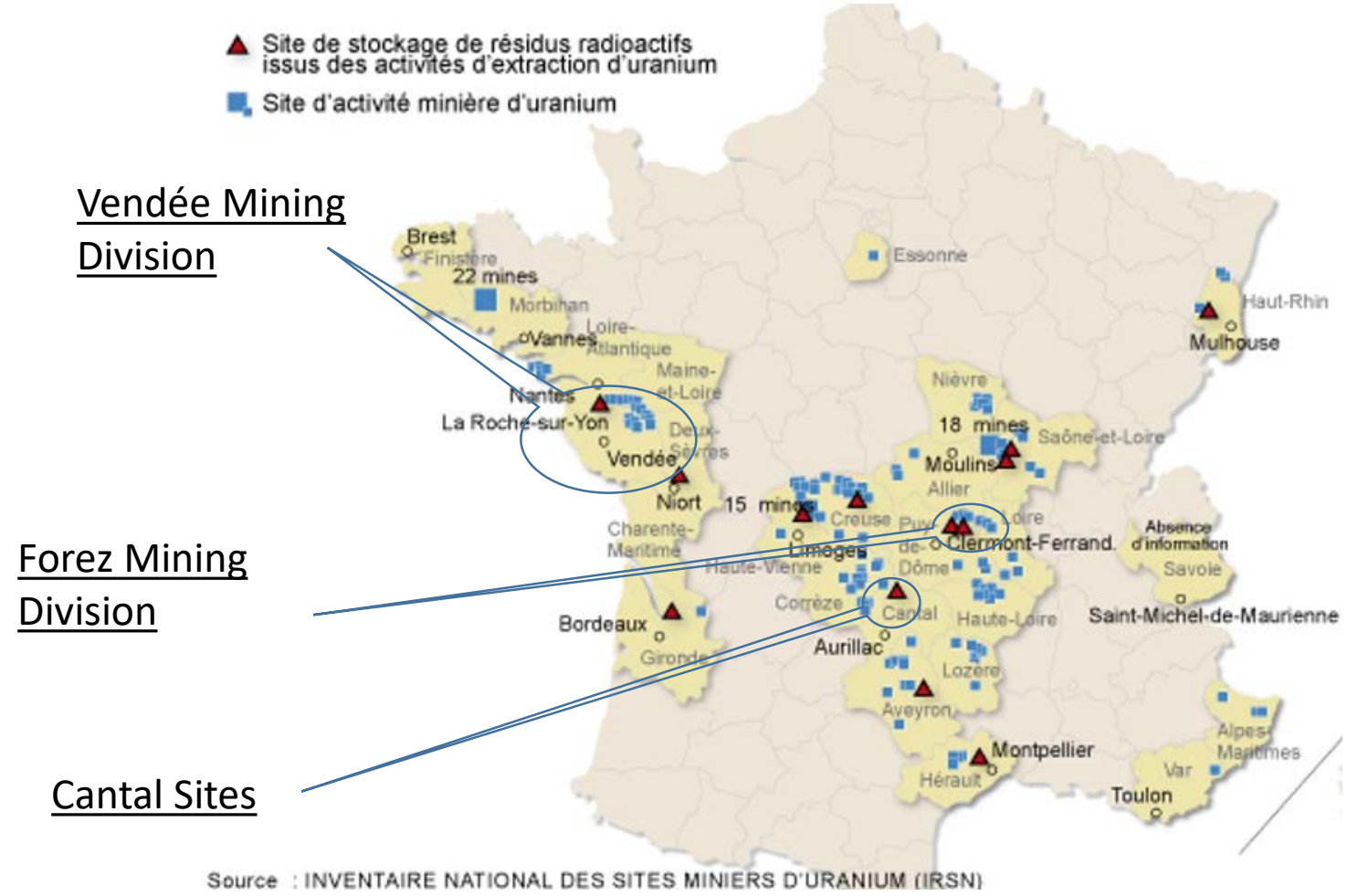
Fukushima, an unanticipated accident which raised questions about the future of nuclear power

A second step, to cross the knowledge between “sciences of the matter” and human and social sciences

An issue that has been addressed since the creation of the ZATU around the mining sites

Systematic cross-site analysis

- ❑ Socio-historical understanding of the mining legacy
- ❑ Geography of risk
- ❑ Low doses in an open environment
- ❑ Regulation methods - Mining and environmental law



A project that starts around the mineral springs

SOURCE DU PETIT SALADIS

Les Martres-de-Veyre (Puy-de-Dôme)

SOURCE DU CORNET

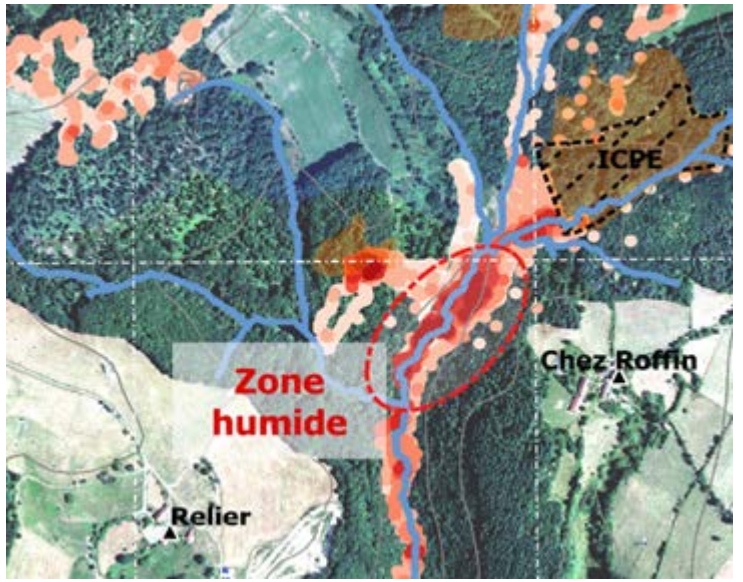
au Puy-de-Corent (Puy-de-Dôme)

par N9 au sud de Clermond-Ferrand puis D225

Ces deux sources se sont trouvées associées dans les recherches effectuées par deux médecins auvergnats, les docteurs Bruyère et Cacan, qui sont parvenus à mettre au point une posologie de leurs eaux.

Le Petit Saladis[1] n'est pourtant pas de ces sources où l'on irait volontiers se désaltérer. Un peu sale et légèrement colorée, l'eau stagne dans une mare à canards : elle a l'étonnante propriété d'être radioactive.

The miraculous water from the Saladis spring



Rophin Creek water in the wetland

E. Pezé, ***Les nouveaux lieux miraculeux***

Some basic information

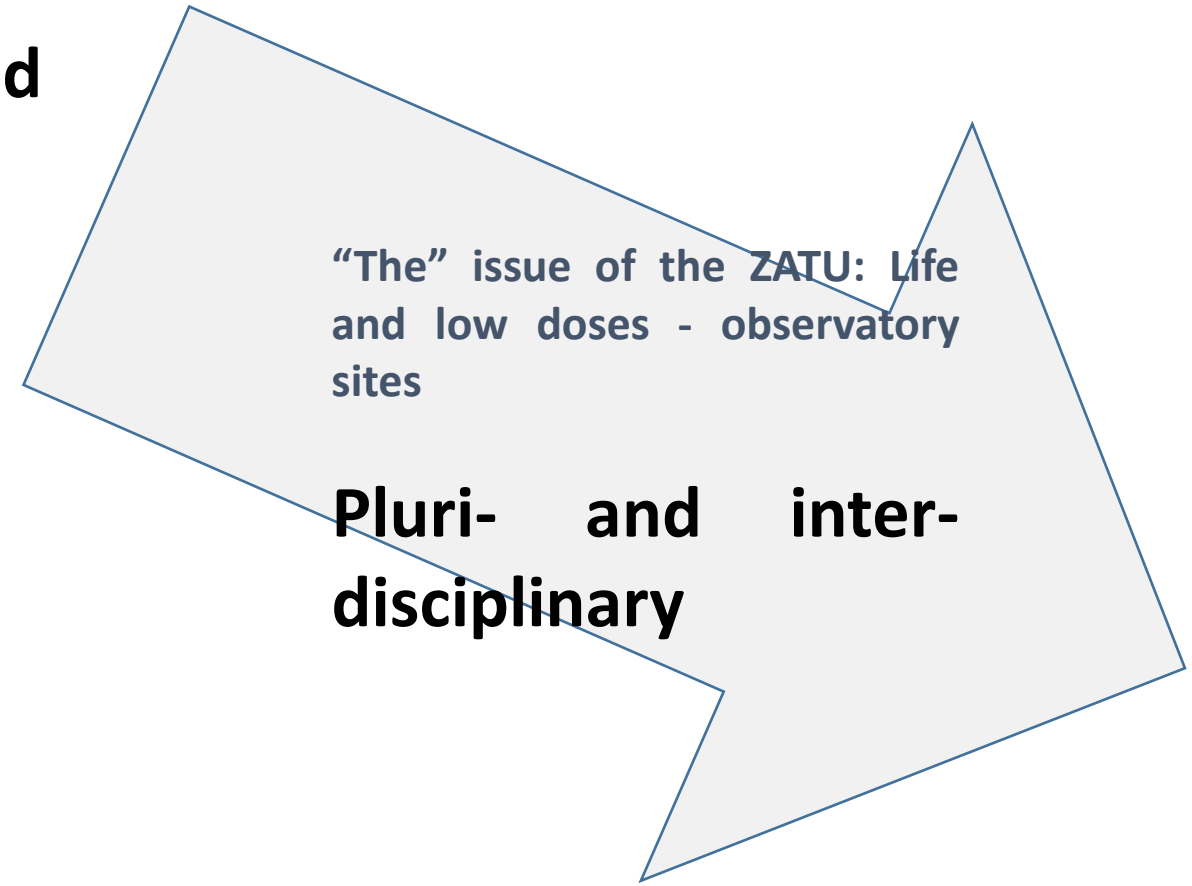
Where are we now?

Where are we going?

A long way to go!

"My" scientific question

Disciplinary field



Conservatoire d'espaces naturels Auvergne

The territory and its sustainable development
The socio-ecological system

Trans- disciplinary

A new project created this year

It is centered on the crossing of academic knowledge with **intuitive/empirical knowledge** (doctors, local population,…)

It is inscribed on the **scale of the territory** with the ambition of an **internationalization** of the research program

It leads us, among other things, to the **knowledge of the first nations**….

Radioactivity & local Knowledge

Confronting the Angry Rock: American Indians' Situated Risks from Radioactivity

Richard W. Stoffle & Richard Arnold
University of Arizona, Tucson & Las Vegas Indian Center, Nevada, USA

ABSTRACT *Numic people in the western United States are co-adapted with their traditional lands and these lands are spiritually and physically co-adapted with these people. This relationship has been documented through studies funded by the Department of Energy, Nevada Operations.[1] Elders from twenty-six Indian tribes participated in two studies in order to explain why the transportation of radioactive waste poses serious threats. Key in their interpretation is the perception that radioactive material is an angry rock. Indian knowledge and use of this rock goes back for thousands of years. As a powerful spiritual being the angry rock constitutes a threat that can neither be contained nor controlled by conventional means. It has the power to pollute food, medicine, and places, none of which can be used afterwards by Indian people. Spiritual impacts are even more threatening, given that the angry rock would pass along highways where there are animal creation places, access to spiritual beings, and unsung human souls. A most troubling concern is that radioactivity would be transported along the path to the afterlife. The juxtaposition of the angry rock and human spirits being sung to the afterlife is unthinkable.*

KEYWORD *Radioactive waste, risk perception, US Department of Energy*

« the Angry Rock »

Barbra E. Erickson
Department of Anthropology
California State University, Fullerton

Toxin or Medicine?

Explanatory Models of Radon in Montana Health Mines

Environmental protection and public health agencies in the United States and elsewhere label radioactive radon gas a toxic environmental hazard and a major cause of lung cancer. Paradoxically, in Europe and Japan radon gas is also used as an analgesic and anti-inflammatory, as one choice in the spectrum of conventional medical care. Although it is possible to find radon therapy in the United States, it exists only as an unconventional practice in Montana "radon health mines." In this article, I examine the use of radon therapy by Americans despite intensive public health education media campaigns. Using the notion of explanatory models as an analytical framework, I argue that American health mine clients adjust or replace "toxic models" of radon with new kinds of explanatory models that allow radon to be redefined as a healing substance. The manner of this adjustment varies according to peoples' individual needs, their own preexisting cultural models and experiences, and their individual personalities; the source of authoritative knowledge accepted by each person is a strong influence. Through these altered explanatory models, mine clients are able to view their use of radon therapy as a rational course of action.

Keywords: [radon, explanatory models, health care choices, environmental toxins]

« the kiss of god » (radon)

Another way of looking at the future - how to maintain sustainability in relation to mining

In Australia, an Aborigine prevents Areva's uranium mining projects (Orano)

"J'ai dit non aux mines d'uranium à Koongarra, car je crois que la terre et les croyances propres à ma culture sont plus importantes que l'exploitation minière et l'argent. L'argent va et vient, mais la terre est toujours là, subsiste toujours si nous nous en occupons, et s'occupera toujours de nous."
Se trouvent à Koongarra de **l'art rupestre aborigène, des sites sacrés, des roches ocres et de la brousse** "

Le Monde

Quand les savoirs autochtones questionnent la science

knowledge
longtemps m
précieux de la sci

Peuples premiers, peuples racines

FREDERIKA VAN INGEN

« Votre savoir arrive aux mêmes constats que le nôtre. Mais à quoi sert une pensée, si elle ne débouche pas sur une action ? » demandaient aux chercheurs trois Kogis venus dans la Drôme pour un diagnostic de santé du territoire en 2018. Pour eux, le savoir doit servir à entretenir l'équilibre de la vie.

Chendukua
Ici et Ailleurs

A new cross-diagnosis planned to assess the territorial health of the “**bassin lémanique et du Rhône »;** a second step with the perspective of contributing **to the sustainable development of this territory**

21-22/10: about 50 scientists and representatives of the civil society met in Geneva to prepare this event

https://youtu.be/eNDEJz74lT8

Tchendukua Ici et Ailleurs

Challenge: From risk to the « health » of a territory?

In short, to evaluate the “health” of a territory from a holistic point of view, it is important to cross the scientists' view with the “local” knowledge but also the knowledge of the first nations

A possible way to go towards sustainability by “caring” for the territory?

I thank my colleagues who helped me prepare this presentation

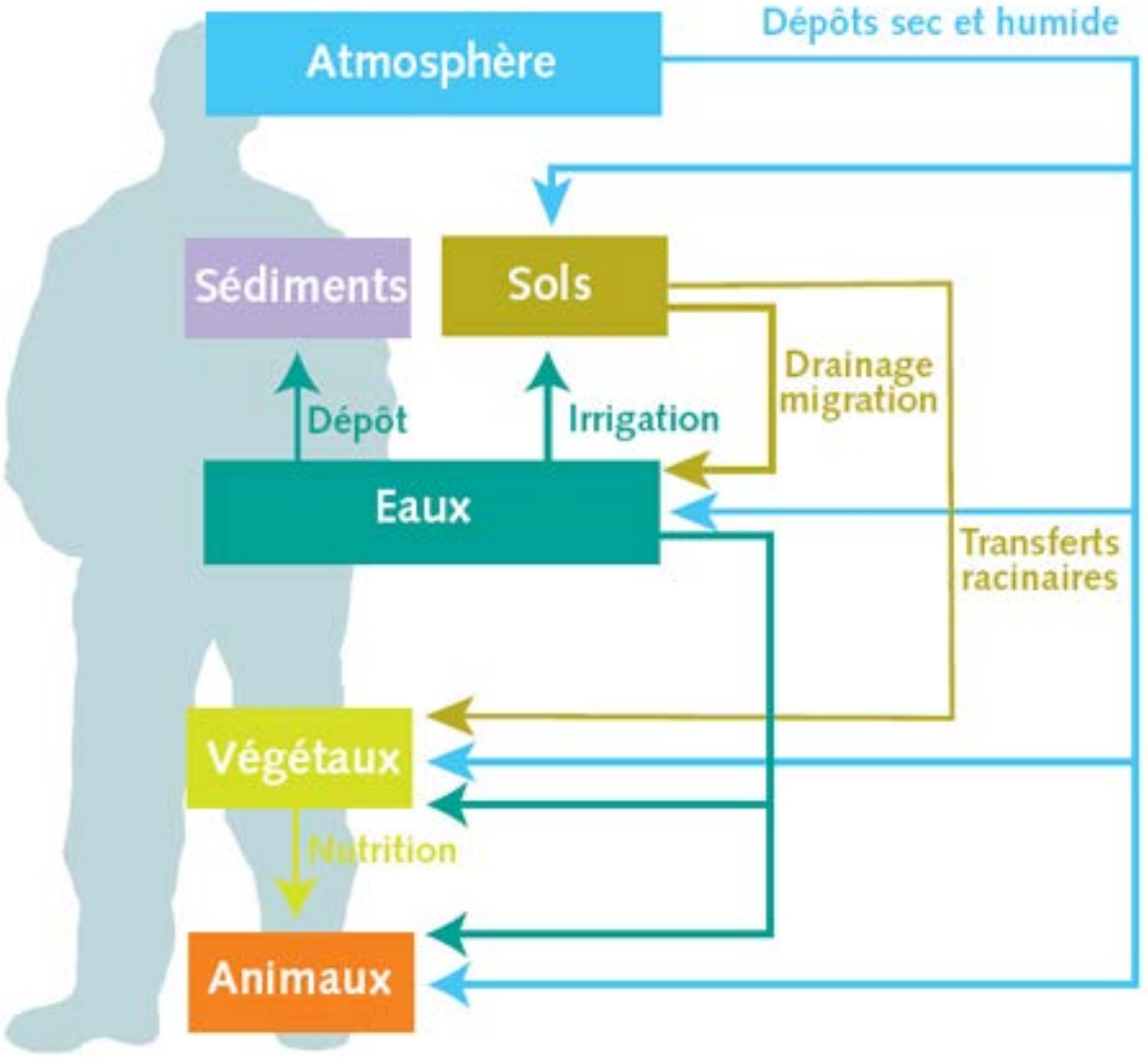
Sylvia Becerra, sociologist, who takes us to new territories in Ecuador (country of thermalism) and in Peru (country of thermalism with an important pressure around the exploitation of Li and U)

Clarisse Malet, micro-biologist, our link with the living in these « extreme » environments

Patrick Chardon, specialist in nuclear metrology, co-leader of ZATU, who is interested in thermalism in Auvergne

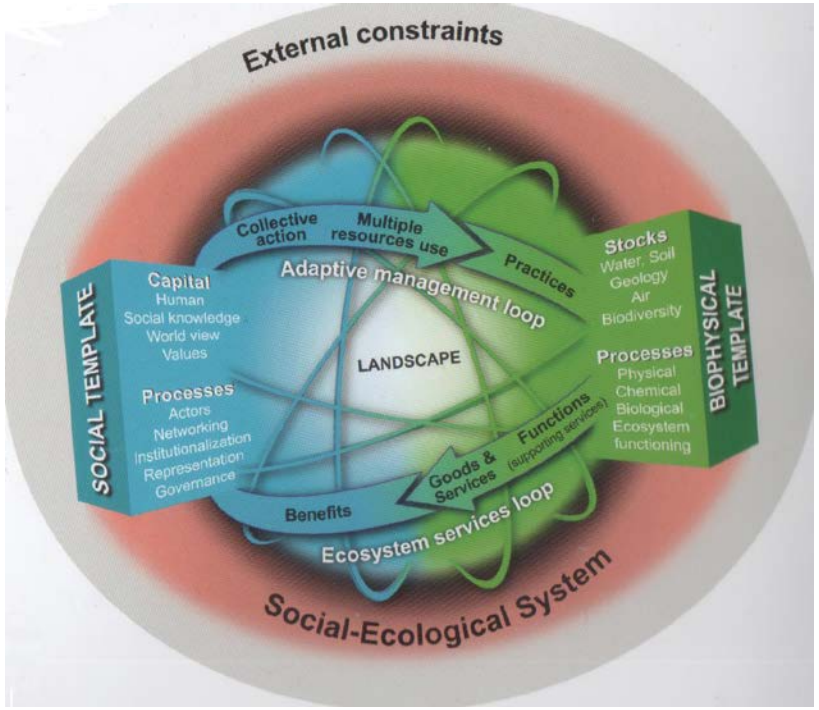
Nathalie Michel, physicist, our link with the Kogis people and the TranceScience Research Institute

we can refine the parameters introduced in the operational models for a better evaluation of the risks (Tf, Kd...)



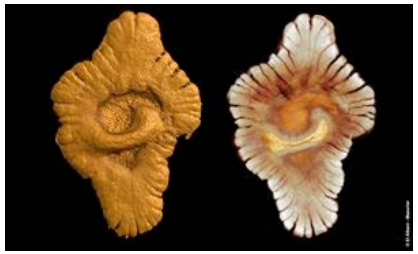
Bridge to cross (step 3)

From observatory sites to the territory?



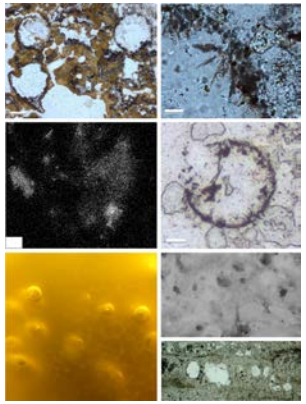
Radioactivity and the origin of life?

Notice the melted rocks from the heat of fission reaction which happen Billion years



El Albani et al, Nature 2010

The 1st multicellular organisms were discovered 30 km from natural nuclear reactors in Oklo (Gabon); **multicellular life already existed 2.1 billion years ago**



First signs of terrestrial life in hydrothermal spring deposits (Australia); Life has been present on Earth **for nearly 4 billion years!**

T. Djokic et al, Nature Communications, 2017