PIXIL

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Fondo Europeo de Desarrollo Regional (FEDER)

UNIÓN EUROPEA
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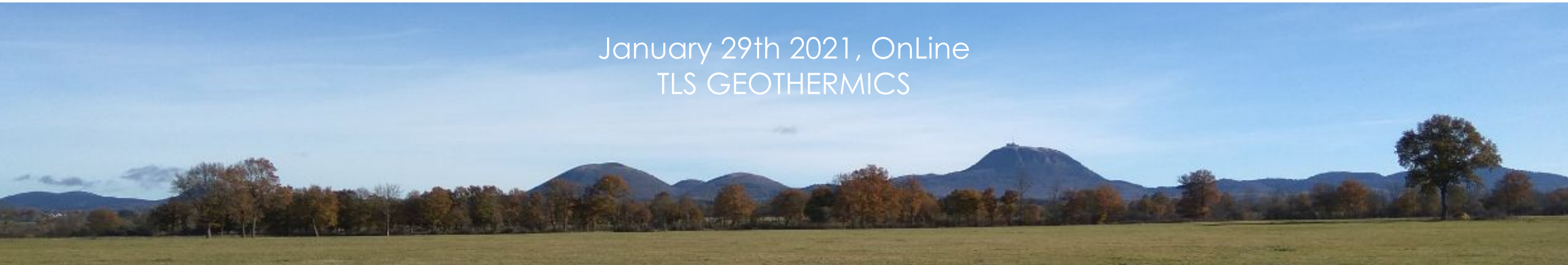
GEO-URBAN GEOTHERMICA

TLS GEOTHERMICS

Deep geothermal in basement rocks, perspectives for Spain and France addressed with a real case study



January 29th 2021, OnLine
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Who we are

Mathieu Auxiètre, CEO
Finance background, 2012

Mathieu Bellanger, PhD
Research Geologist, 2014

Jean-Luc Auxiètre, PhD
Geosciences advisor & expert
Oil&Gas background, 2012

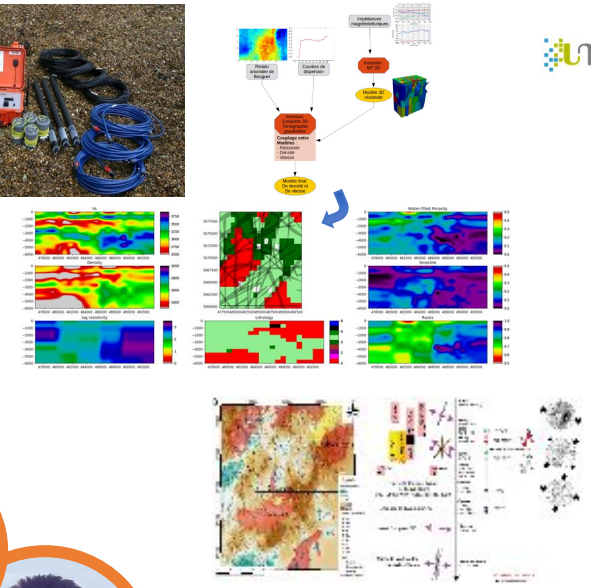
Emilie Bessagnet
Human resources & accountability, 2018

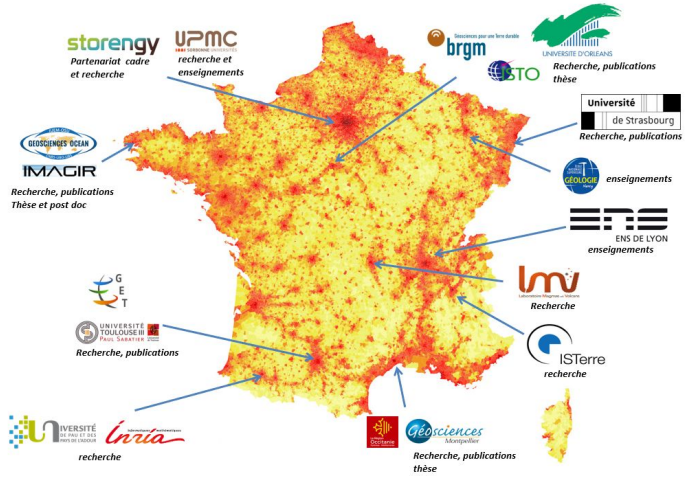
Bastien Hermant
Research Geologist, 2017

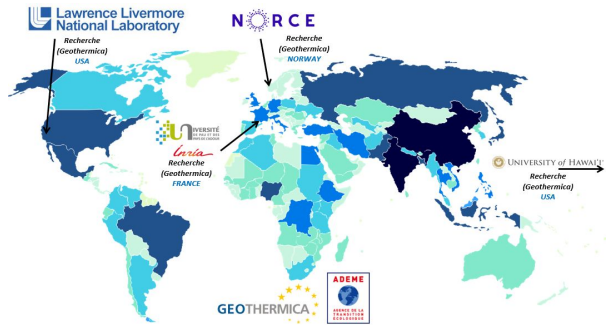
Olivier Schang
Business Developer, 2020

Hugo Duwiquet,
PhD student geologist, 2019

- Operator-developer (3 licenses)
- Strong focus on geosciences to derisk our projects (concepts & tools)
- Field & numerical works







- Collaborations with several universities in France and Int'l
- Consulting & services

Public supports :

bpifrance

anrt association nationale recherche technologie

ADEME AGENCE DE LA TRANSITION ÉCOLOGIQUE

avenia

LES PÔLES DE COMPÉTITIVITÉ

La Région Occitanie Pyrénées - Méditerranée

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Our approach: R&D agility

Conceptualisation

- Worldwide databases
- Multi- to trans-disciplinary approach
- Spatial & temporal multi-scale approach (from lithosphere to chemistry processes)
- Strong R&D activity
- Best place for geothermal purpose (even when systems are hidden)

Field explorations

- Ressources qualification :
  - Geological knowledge (drain, fluids, heat)
  - Geophysical knowledge (gravimetry, seismic, magnetotelluric, thermodynamic, petrophysics…)
- Ressources quantification (temperature, fluid flow rate, durability, depth):
  - Static modeling (geology, stress state,…)
  - Dynamic modeling (TH, THM)
- Exploration drilling

Development

- Monitoring
- Exploration-tools development
- Power plants projects management
- Replications & Portfolio approach

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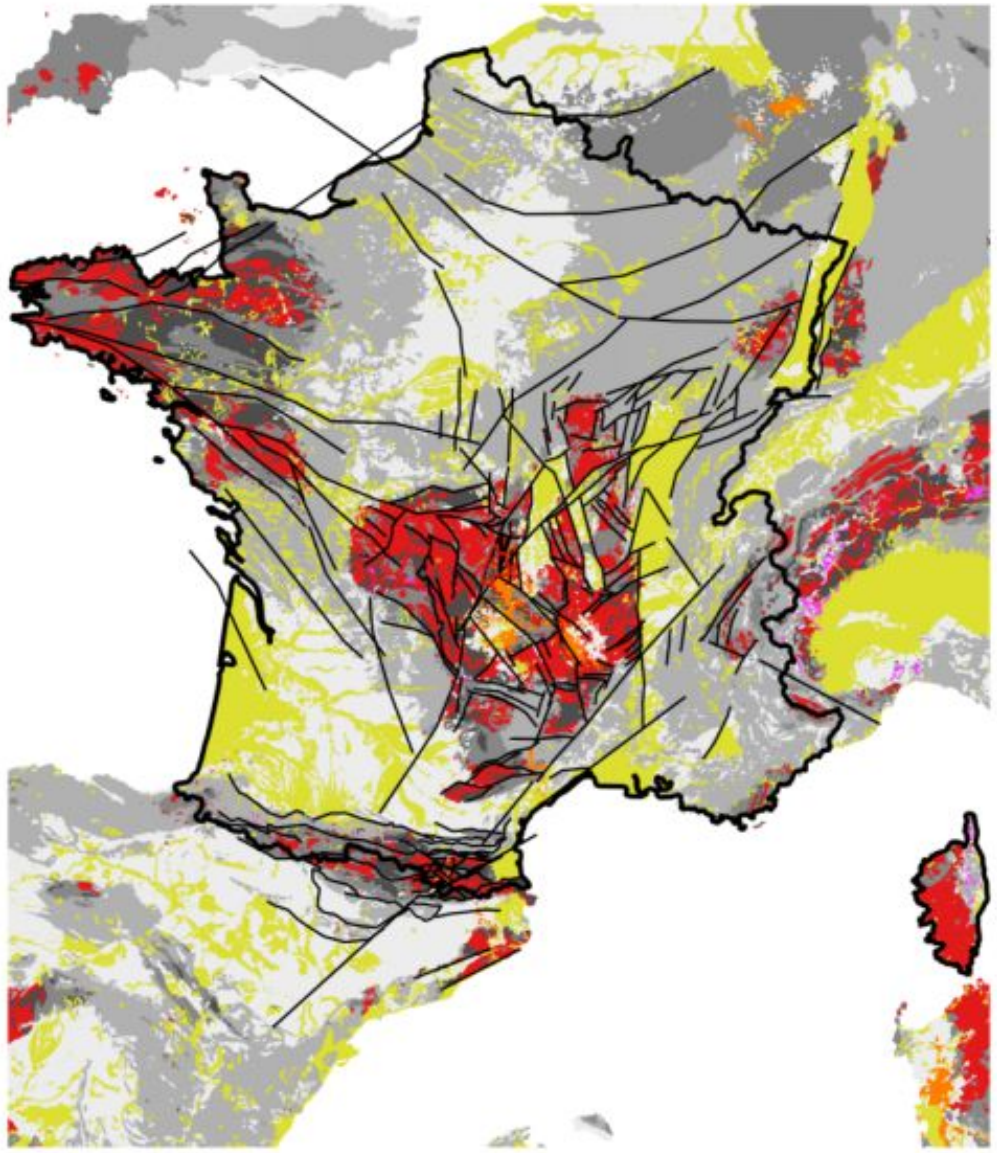
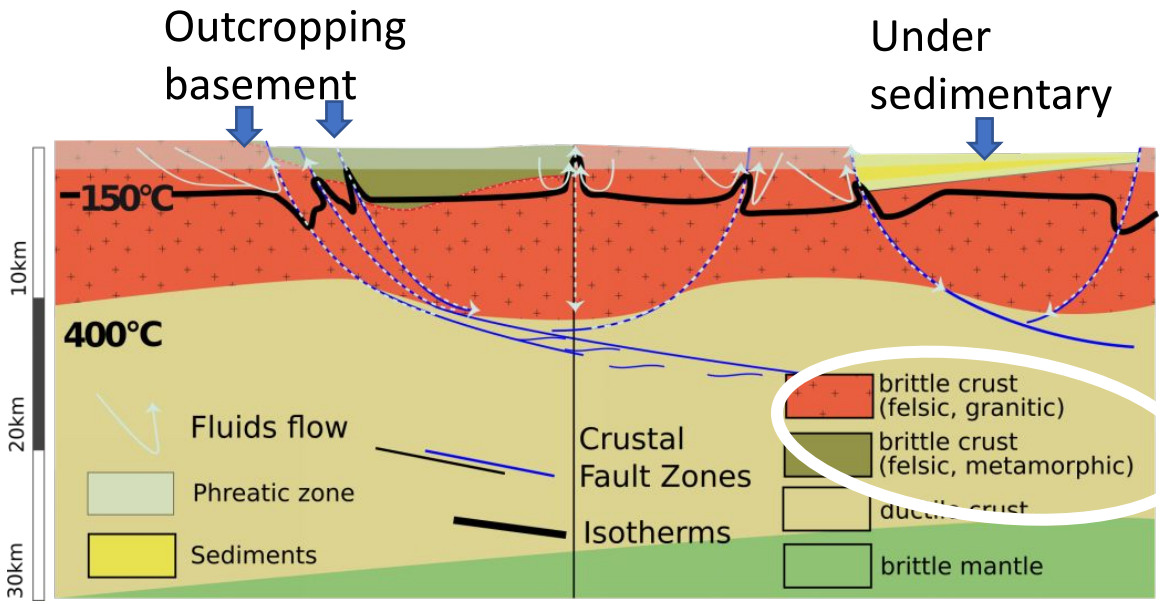
Geothermal in basement rocks ?





Basement ≈ granitic and metamorphic rocks
Outcropping basements offer the advantage to have visible faults on surface, which is not obvious in sedimentary basins, lower seismic risk on surface

Area selection & exploration need to target large crustal faults, with highly viable permeability indicators (fault age, structural measures, fluids, stress state & orientation) rather than solly temperature indicators (heat flow or oil borehole temp. °C)

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Case study : the Sioule License
Geosciences

Sioule,
Pontgibaud fault zone

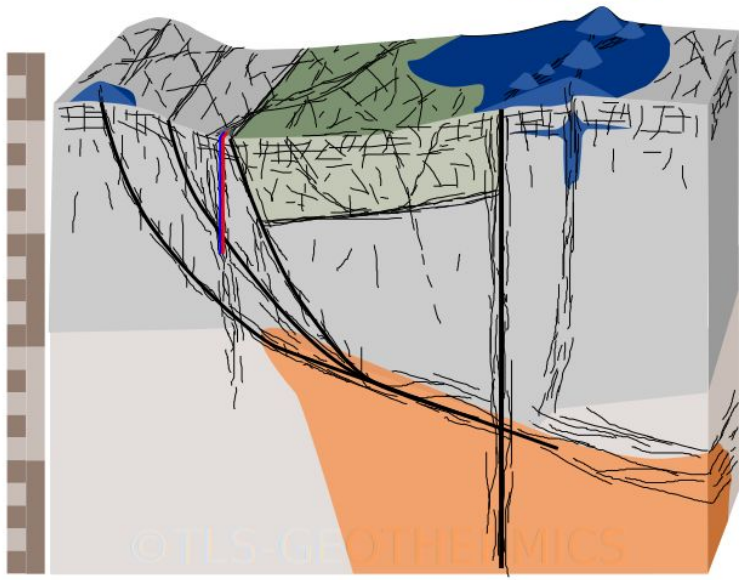
3 km | 170°C | 100L.s^{-1} 40MWth (5MWe)

Fluids
- Meteoric fluids
- Sedimentary fluids
- Magmatic fluids
- Metamorphic fluids
- Mantellic fluids
- Other

Drains
- Sedimentary layers *(eg. Sand)*
- Karsts
- Volcanic layers *(eg. Scoria)*
- Diffuse fractures / alterations *(eg. buried paleosurface)*
- Fractured layers *(i.e. strong mechanical behaviour)*
- Lithological interface
- Crustal fault zone *(i.e. deeply root in hot rocks)*
- Other

Heat
- Hot mass transfer (magmatism)
  - Volcanic
  - Shallow plutonism (*i.e. <10km*)
  - Deep Plutonism (*i.e. >10km*)
- Thermal conductivity contrast
  - Low conductivity effect *(i.e. cover effect)*
  - High conductivity effect *(i.e. salt effect)*
- Matter transformation & deformation
  - Friction
  - Latent heat
  - Phase change (endo- vs. exothermic)
- Radioactivity (U-Th-K)
- Kinematic of fluids (convection cells)
- Other

8-100ka



Fractures & alterations

Solid magmatic rocks

Melt & plutonism

Metamorphic

Brittle granites

Ductile felsic

Crustal fault zone

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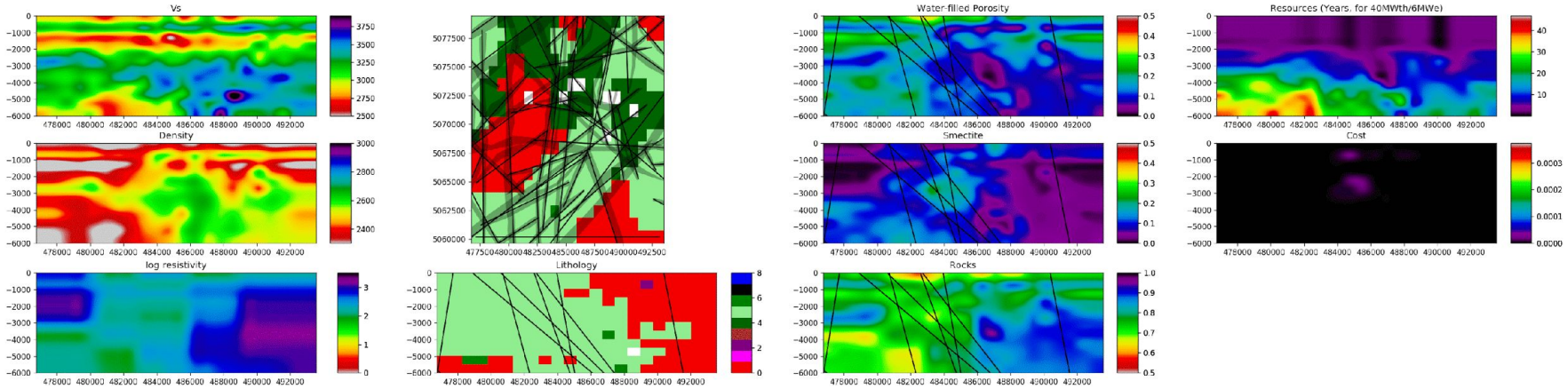
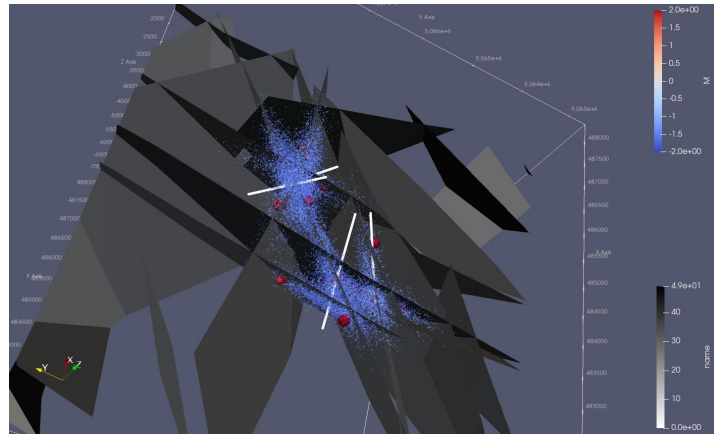
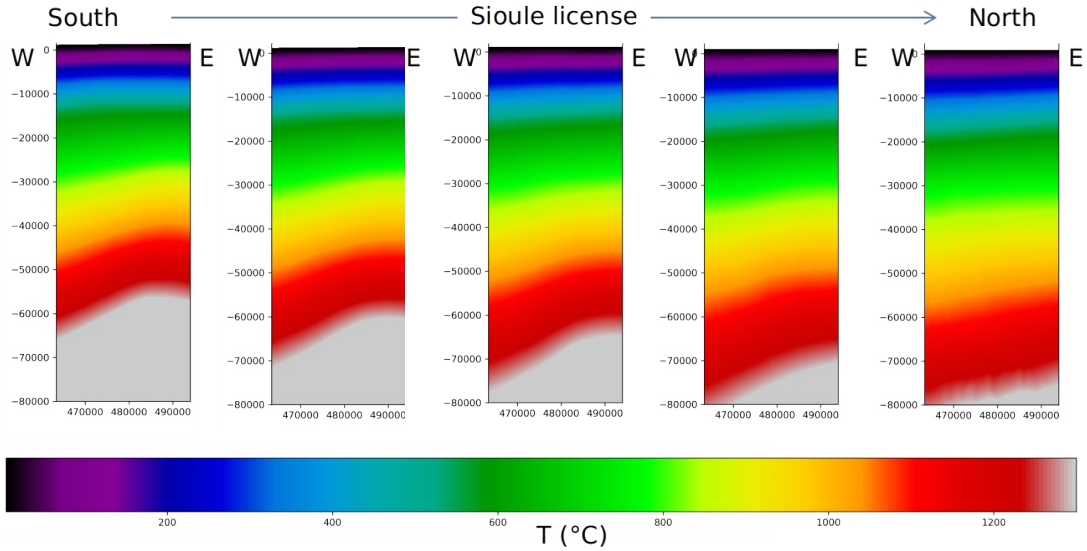
Case study : the Sioule License
Geosciences



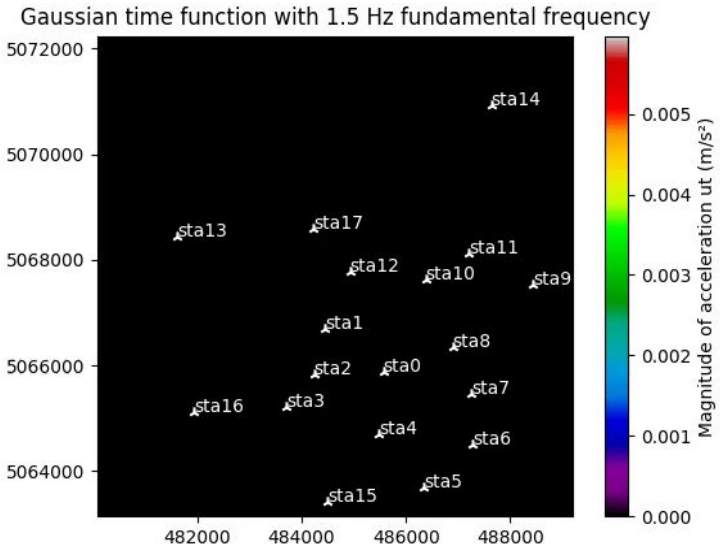
Joint inversion models ➡ converted to petrologic models : porosity, smectite content, fluids contents



Fault model
Microseismic modeling



Thermal models for the license



3d simulation of seismic wave propagation for risk assessment

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Case study : the Sioule License
Summary

- ***License : « La Sioule », western Chaîne des Puys***
- ***Site : St-Pierre-Roche (63 Puy-de-Dôme)***
- ***Planning :***
  - ***November 2021 : drilling starts***
  - ***Feb 2022 : end of drilling and tests***
  - ***Commission Date : 2024***
- ***Depth of reservoir (vertical) : >2500/3000m***
- ***Depth MD (drilled with deviation) : < 4000m***
- ***Targetted temperature : 160 to 200°C***
- ***Targetted Flow rate : 360 m3/h***
- ***Thermal power : >45 MWth (6 to 7 MWe)***

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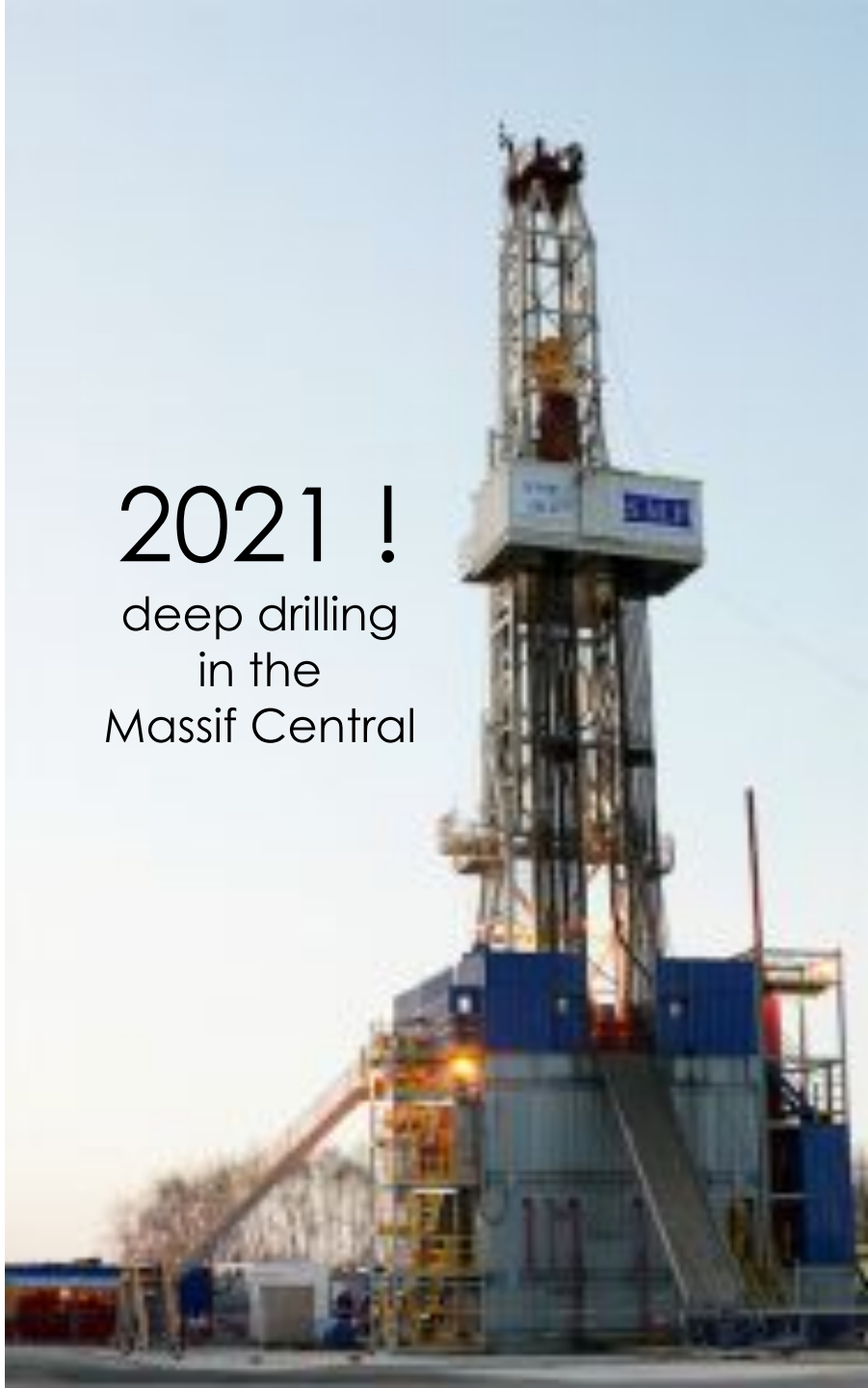
storengy

http://ademe.fr/gofaust



Case study : the Sioule License

Project timeline and partners

2015: License Application MT/Gravi Acquisition

2016: Broadband seismic acquisitions

2017: Ambiant noise tomography
300 nodes acquisition
1 month

2017 : partnership with storengy

2018 : HR models
Drilling site selection

2019 : Environmental impact study (drillings)

2020 : Drilling permit application

2021 : Drilling permit

2022 : test and 2nd drilling

2023 : test and power plant construction

2024 : COD

ISTO

GEOSCIENCES OCEAN

UBO Université de Bretagne Occidentale

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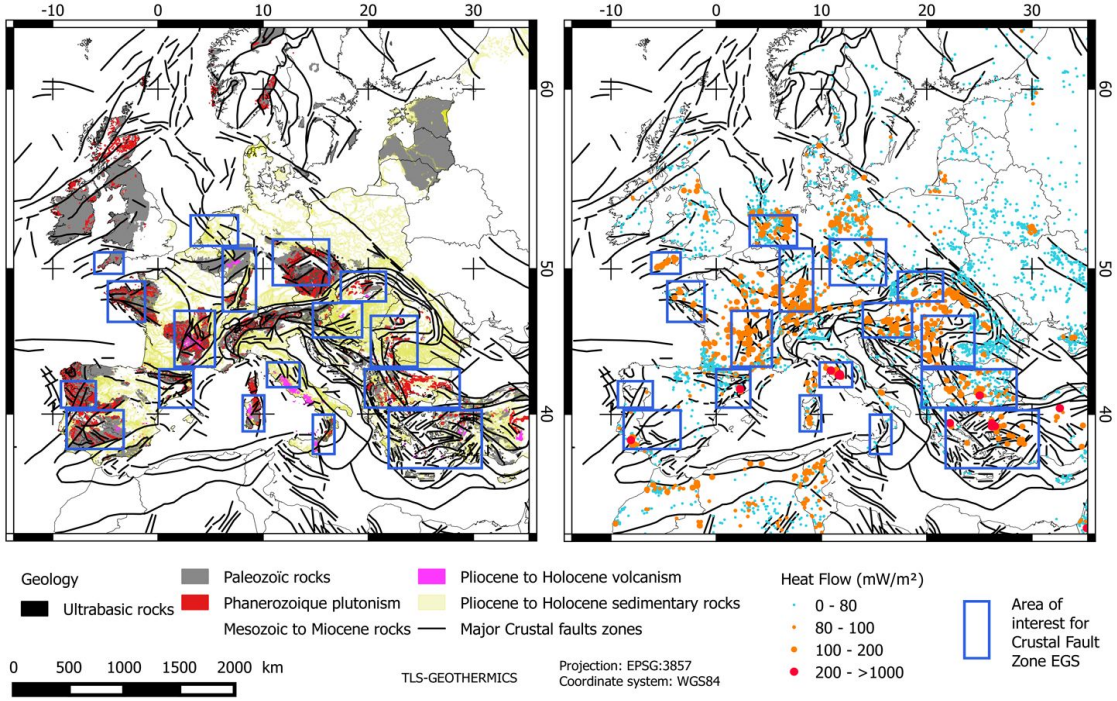
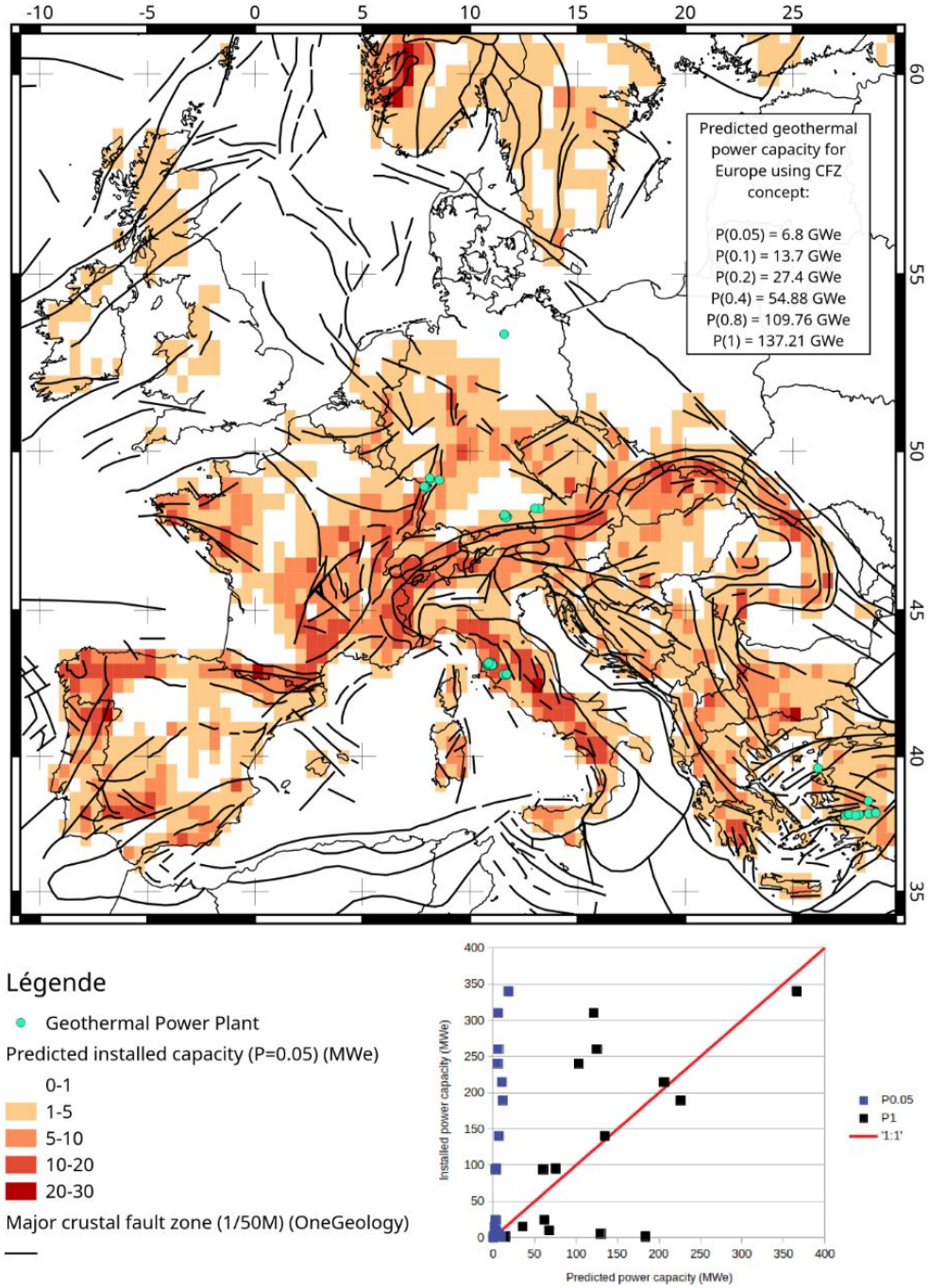
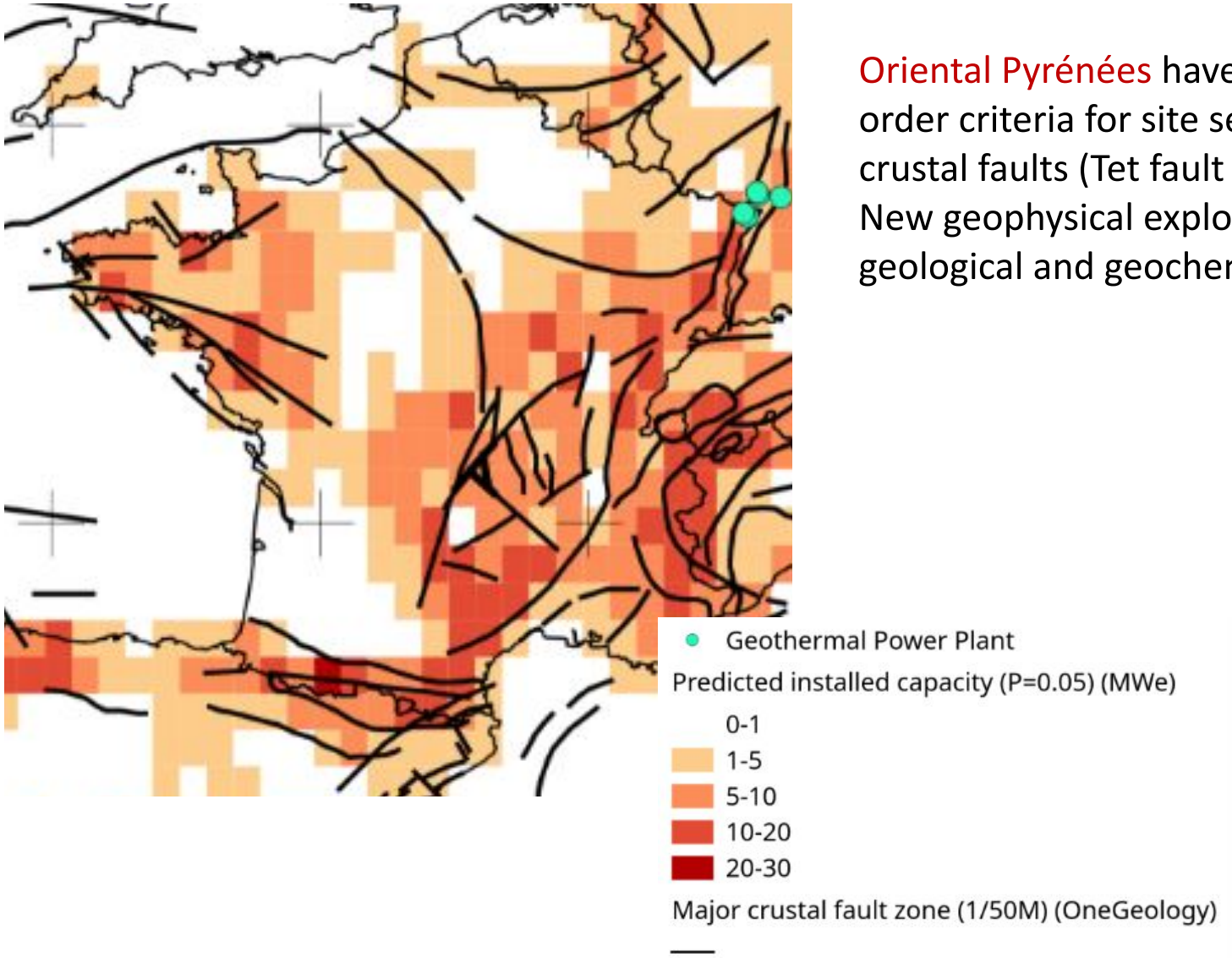
European perspectives

Despite recent stopped power project (Alsace FR), geothermal potential can be significant for power generation, and even more for direct use.
Using new concepts such as Crustal Fault Systems in basement rocks, and targetting high temperature, it can offer numerous new areas for power generation.

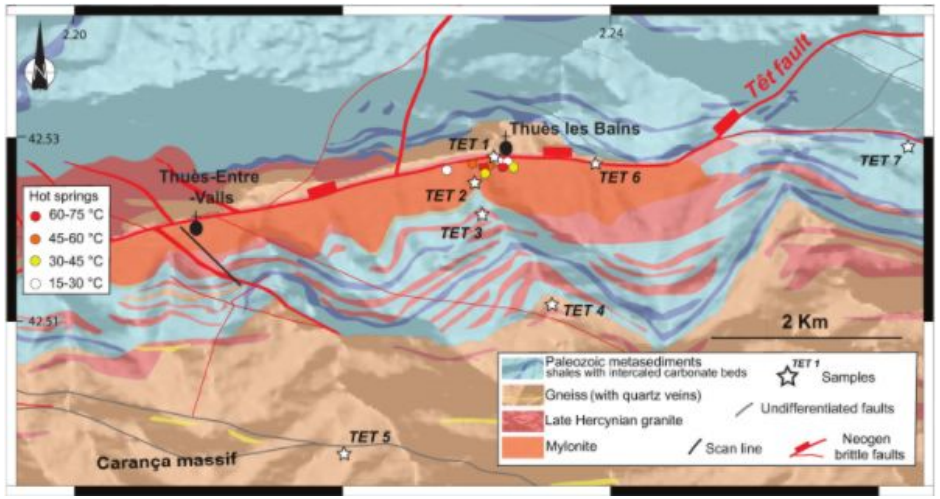




France perspectives (a PIXIL point of view)



Oriental Pyrénées have some favorable factors in terms of 1st order criteria for site selection : granitic bodies, thermal fluids, crustal faults (Tet fault in Cerdagne for example)
New geophysical exploration would be needed after few years of geological and geochemical analysis.



Taillefer et al. / Milesi et al.

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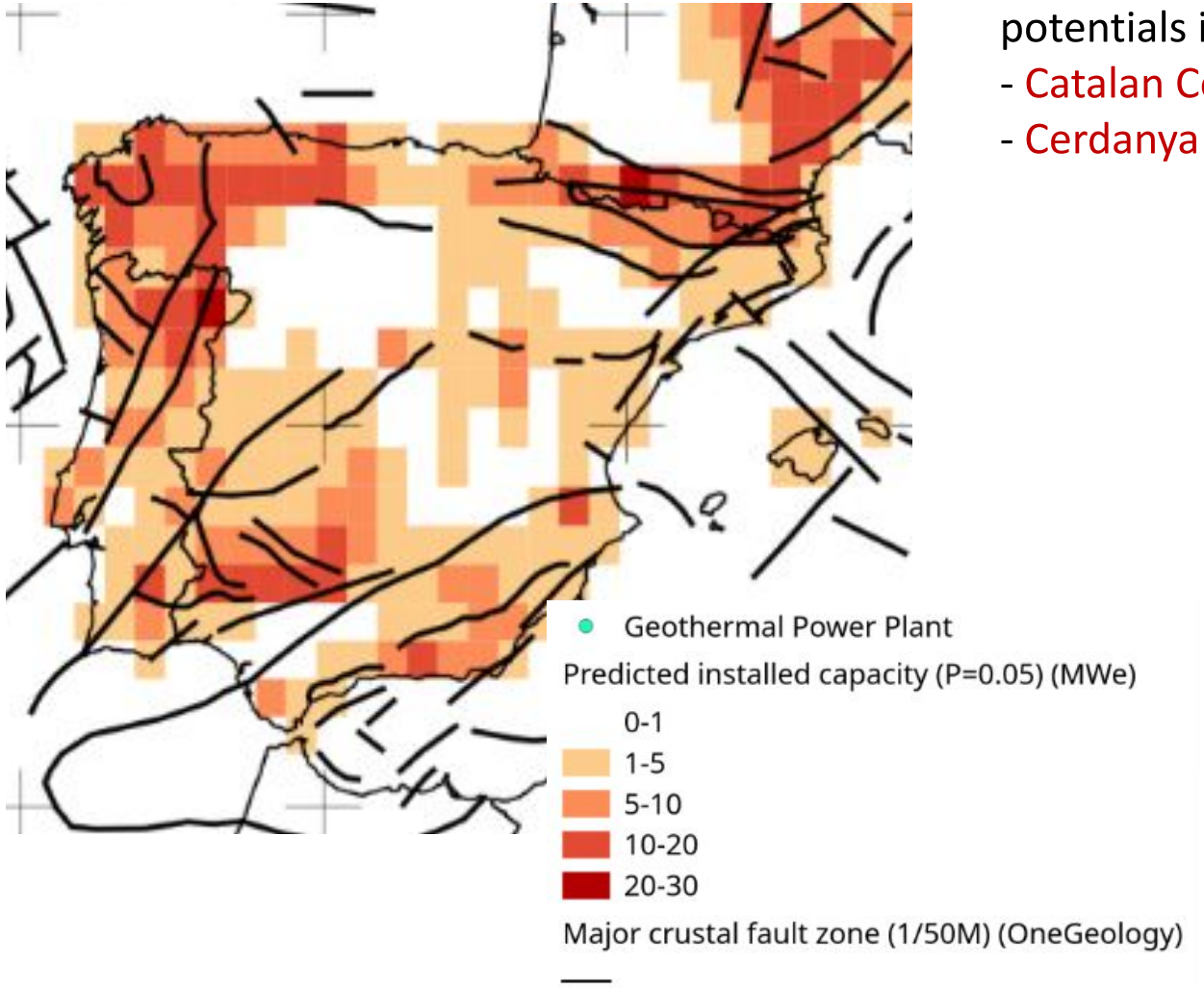
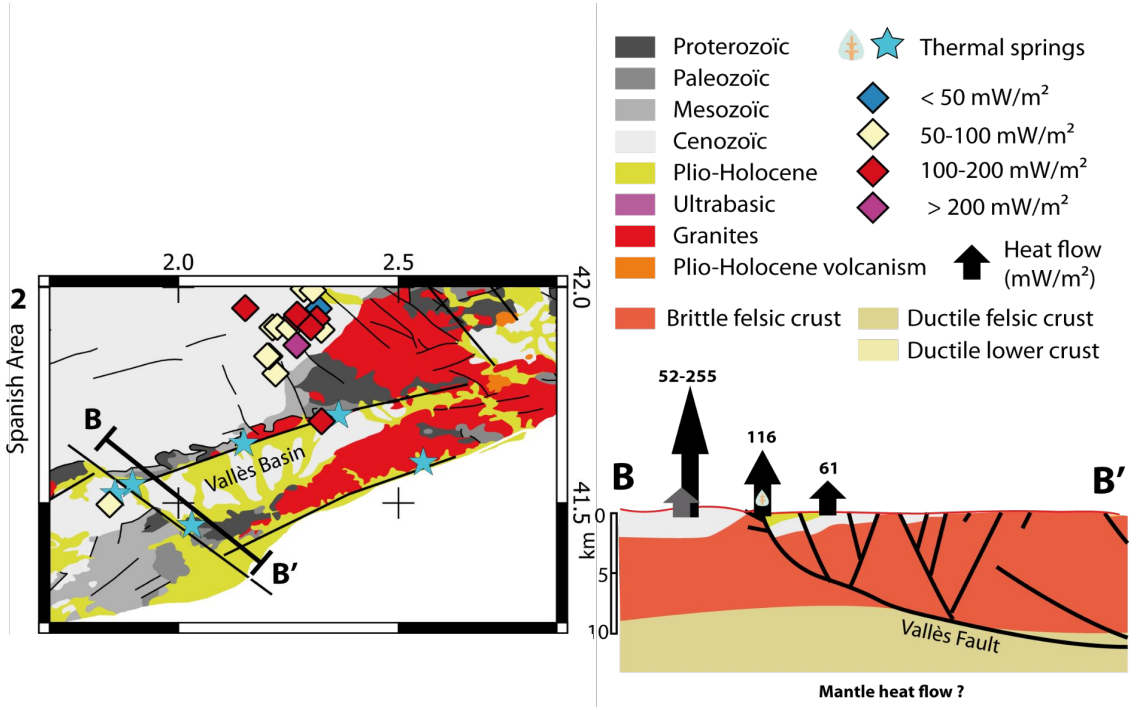
Spain perspectives (a PIXIL point of view)



In Spain, Pyrénées (oriental) and Catalonia region offers some potentials in basement rock.

- Catalan Costal & Pre-Coastal Ranges
- Cerdanya / Cerdaña



PIXIL perspectives - conclusions

Thermal use is for now the only commercial perspective :
- In France, geothermal electricity generation is at its end
- In Spain, geothermal has no feedin tariff (mainland, Canarias ?)

In order to put geothermal energy under the spotlights, we need to inform the decision-makers :
- Governments (national & local)
- Autonomous regions in Spain ; and regions in France
- Better communicate toward the industry & agro industries

Better communicate to decision-makers with new insights & perspectives

Tell that geothermal operations could also provide minerals and metals of interest (lithium, germanium…). Extraction technologies are in the pipes !

We must convince decision-makers that geothermal energy offers cost reduction potential, coproduction and cogeneration

Why not evaluate in the near future the potential of crustal fault zones in basement rocks located within the PIXIL transborder regions !

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Thank you !