



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

**Bundesamt für Energie BFE**  
**Office fédéral de l'énergie OFEN**  
**Ufficio federale dell'energia UFE**  
**Swiss Federal Office of Energy SFOE**



Schweizerischer Erdbebendienst  
Service Sismologique Suisse  
Servizio Sismico Svizzero  
Swiss Seismological Service



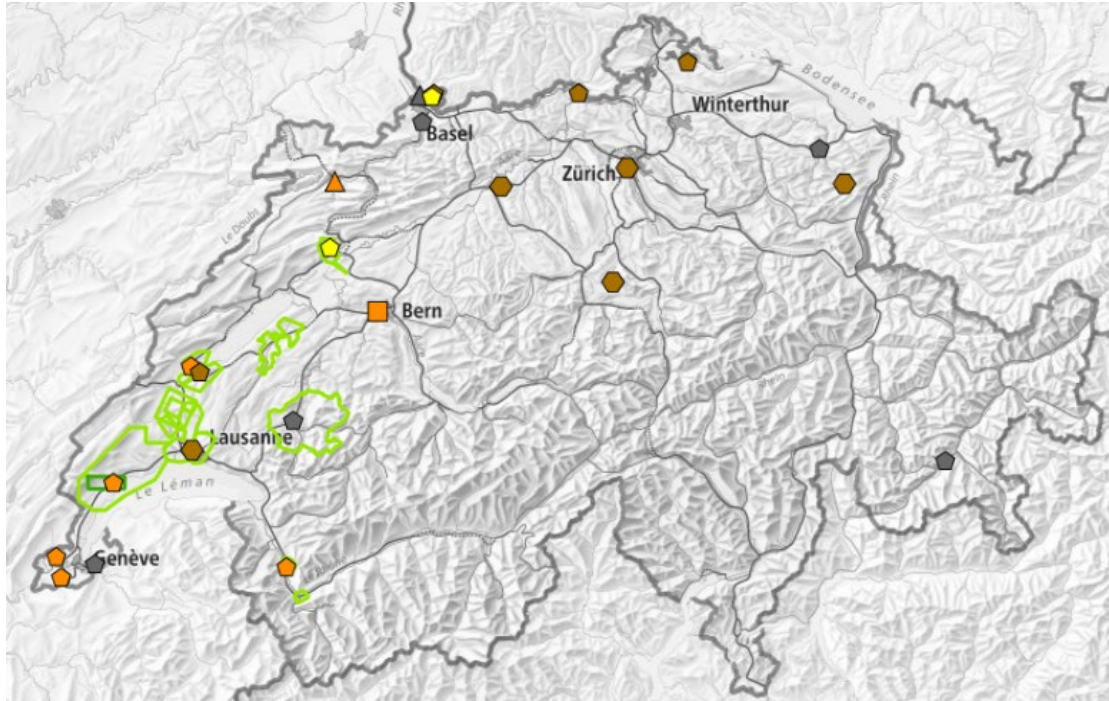
canton de  
**vaud**



## INDUCED SEISMICITY: A COLLABORATIVE APPROACH TO SAFE GEOTHERMAL ENERGY

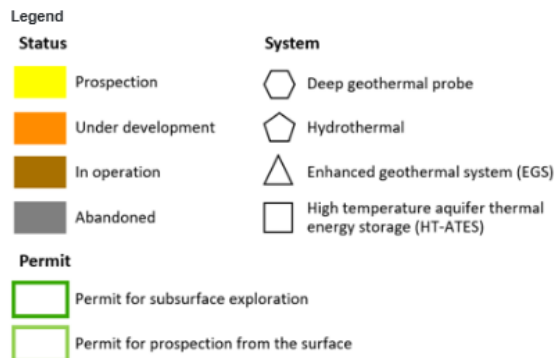
Schatzalp Workshop 2025 ■ 20.03.2025

# Geothermal energy is picking up in Switzerland



www.map.geo.admin

- The Confederation supports the development of **geothermal power and heat production** with 2 federal subsidy programs.
- Federal contribution: **60% of eligible costs**.
- Since 2018: **About 275 mio CHF** invested in 15 subsidised projects:
  - **4 power projects**, including **1 EGS**;
  - **11 direct use for heat production projects**.
- 50 % of all subsidised projects & all ongoing subsidy evaluations are in **Canton Vaud**.





# Why GEOBEST ?

## Fragmented governance & patchwork of regulations



- Subsurface belongs to the 26 cantons: regulation
- Geothermal projects: permits, concessions & regulatory oversight.
- Little experience in the cantons & little industrial practice.
- **Less effective risk management efforts related to induced seismicity**



## Harmonised practices



- **Improved competencies of projects regulators and developers**
- **Improved safety**
- **Supporting sustainable growth of geothermal development**

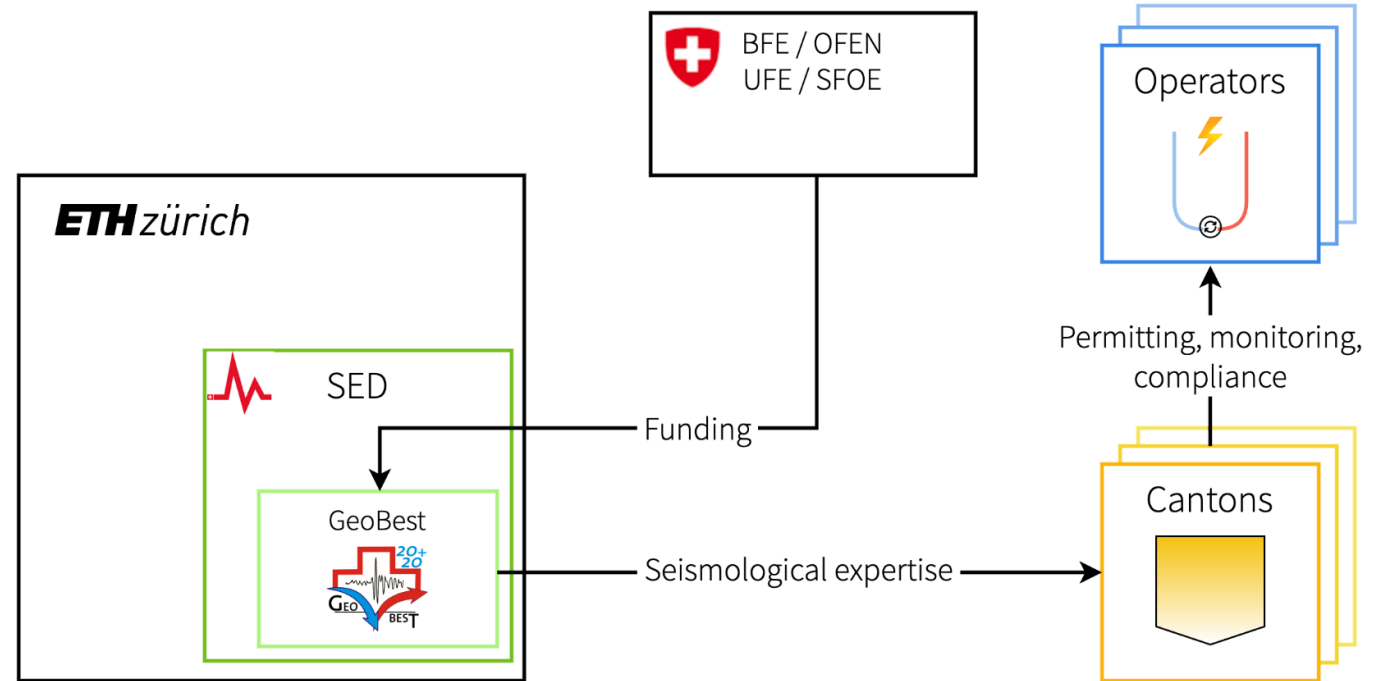


# The GEOBEST program

*Federal seismological expertise made available for the cantons*

Since 2010 and until at least the end of 2027, the GEOBEST program is funded by the SFOE and provides since 2023 exclusively for the cantons:

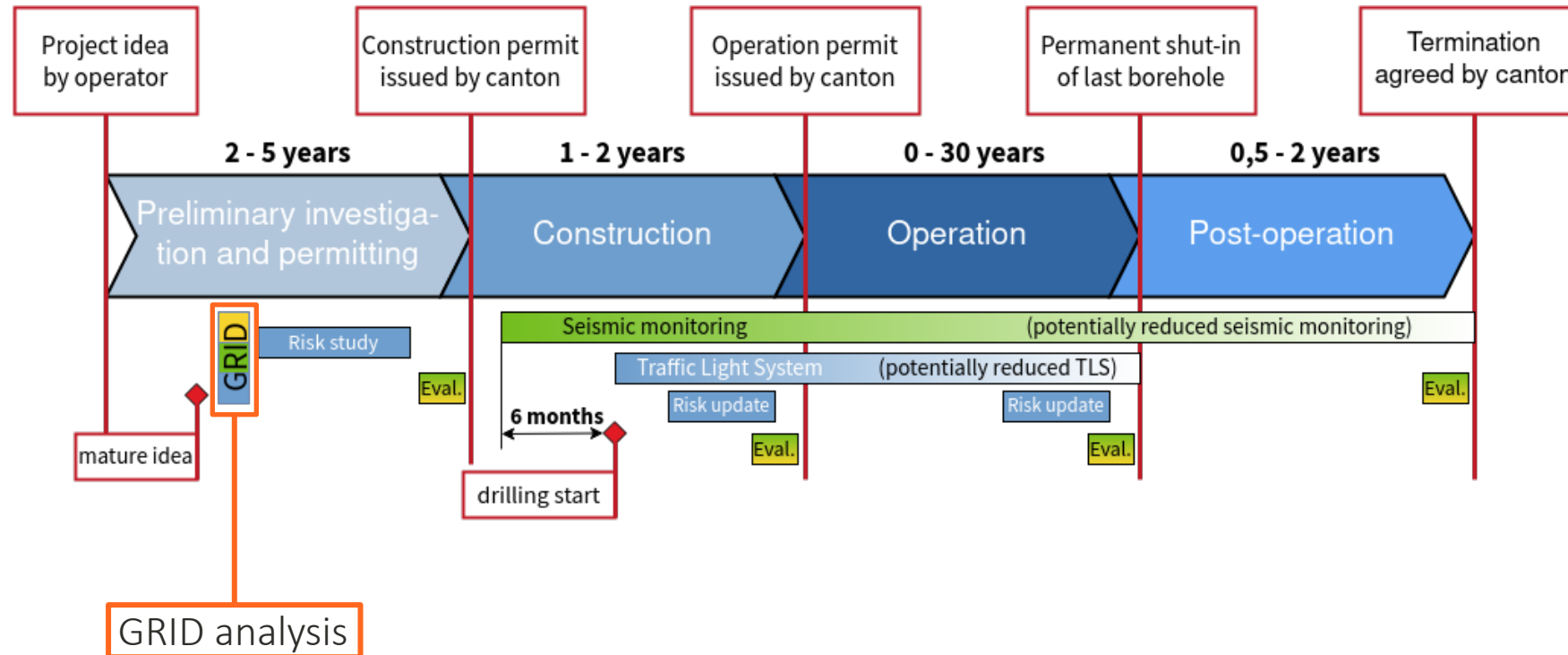
- Seismic monitoring and alerting for deep geothermal projects using the know-how of SED
  - Infrastructure for real-time alerting
  - Pool of instruments for parallel monitoring of several projects
- Seismological consulting on induced seismicity and the assessment of hazard and risk studies.
- Promotion of good practice in the management of induced seismicity.



# The GEOBEST workflow

*Seismological consulting and expertise throughout the life-cycle of a geothermal project*

Actors:  
cantonal authorities  
project operators  
SED



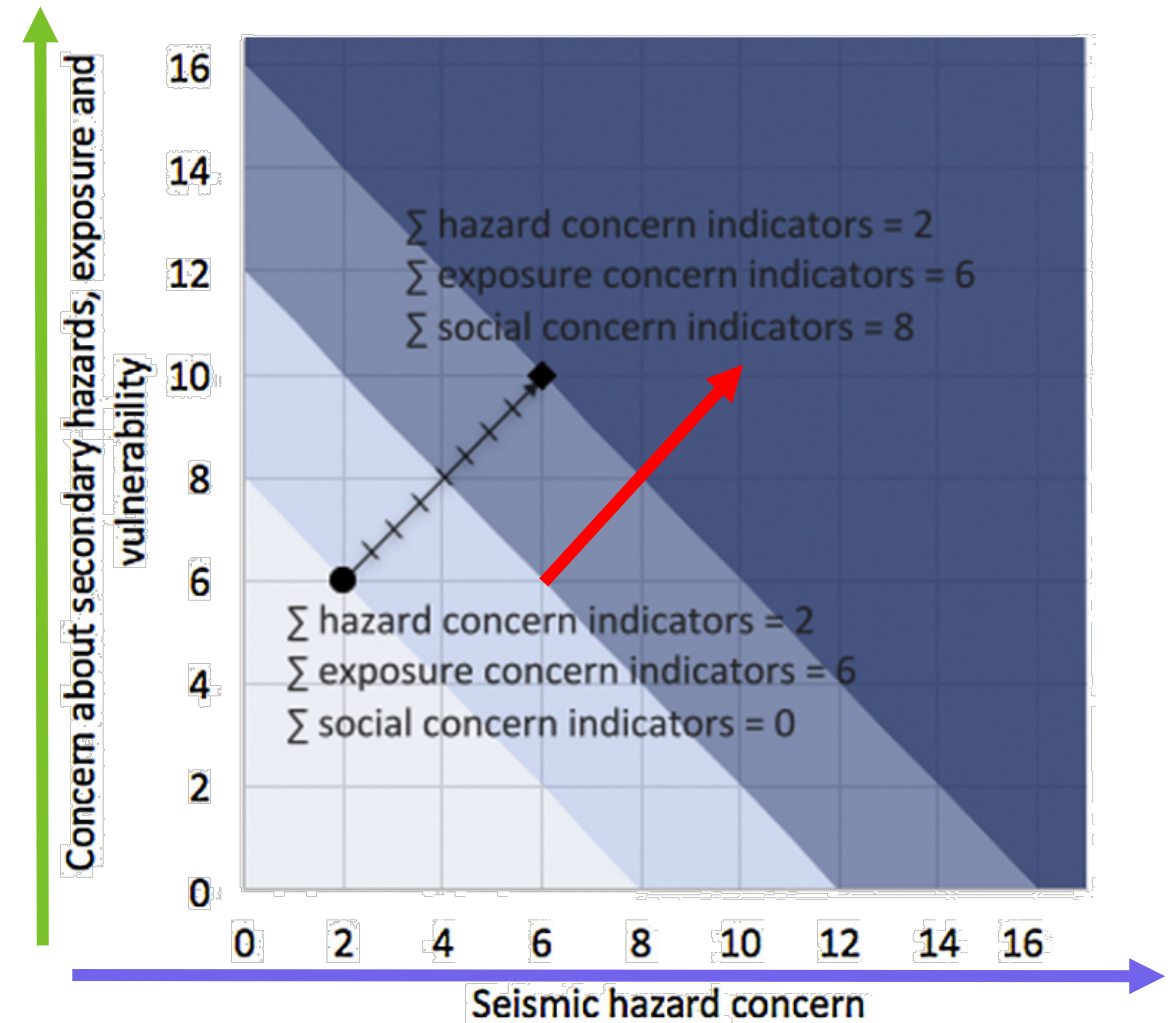
# GRID: Geothermal Risk of Induced Seismicity Diagnosis

## *A global approach to risk governance*

GRID is an objective characterisation tool to help the different stakeholders to make decisions about the risk of induced seismicity.

The GRID analysis includes the quantification of aspects of:

- seismic hazard
- seismic risk
- social concern

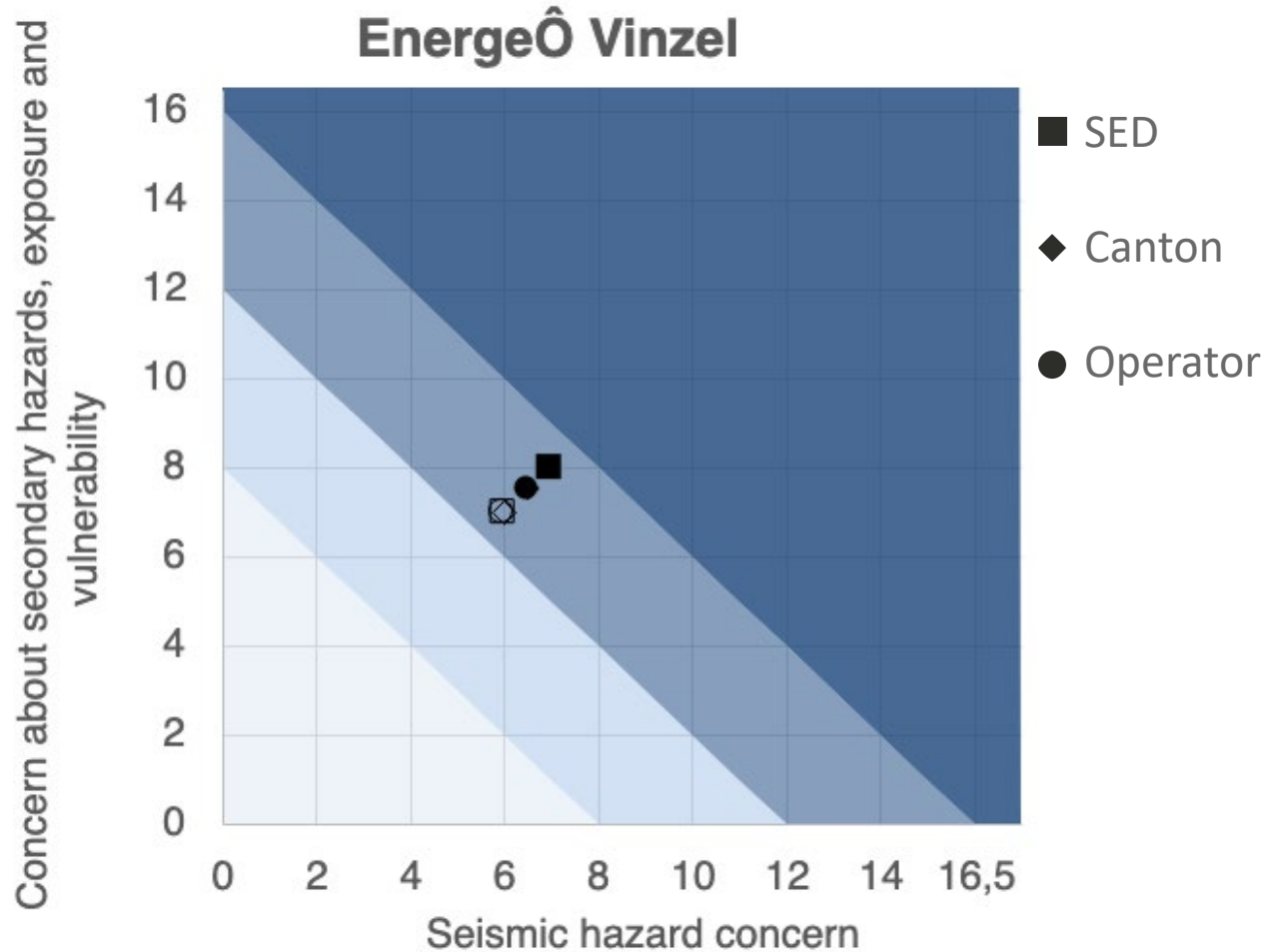


# GRID: **G**eothermal **R**isk of **I**nduced Seismicity **D**iagnosis

## *Example of the EnergeÖ – Vinzel project*

A few key facts about the geothermal project:

- Hydrothermal project targeting naturally fractured rocks in the damage zone of a known fault in the Malm and Dogger.
- Maximum depth 2300 m
- No hydraulic stimulation
- 30'000 inhabitants within 5 km radius
- General positive attitude towards geothermal in the canton
- Planned direct use for district heating



# The GEOBEST workflow

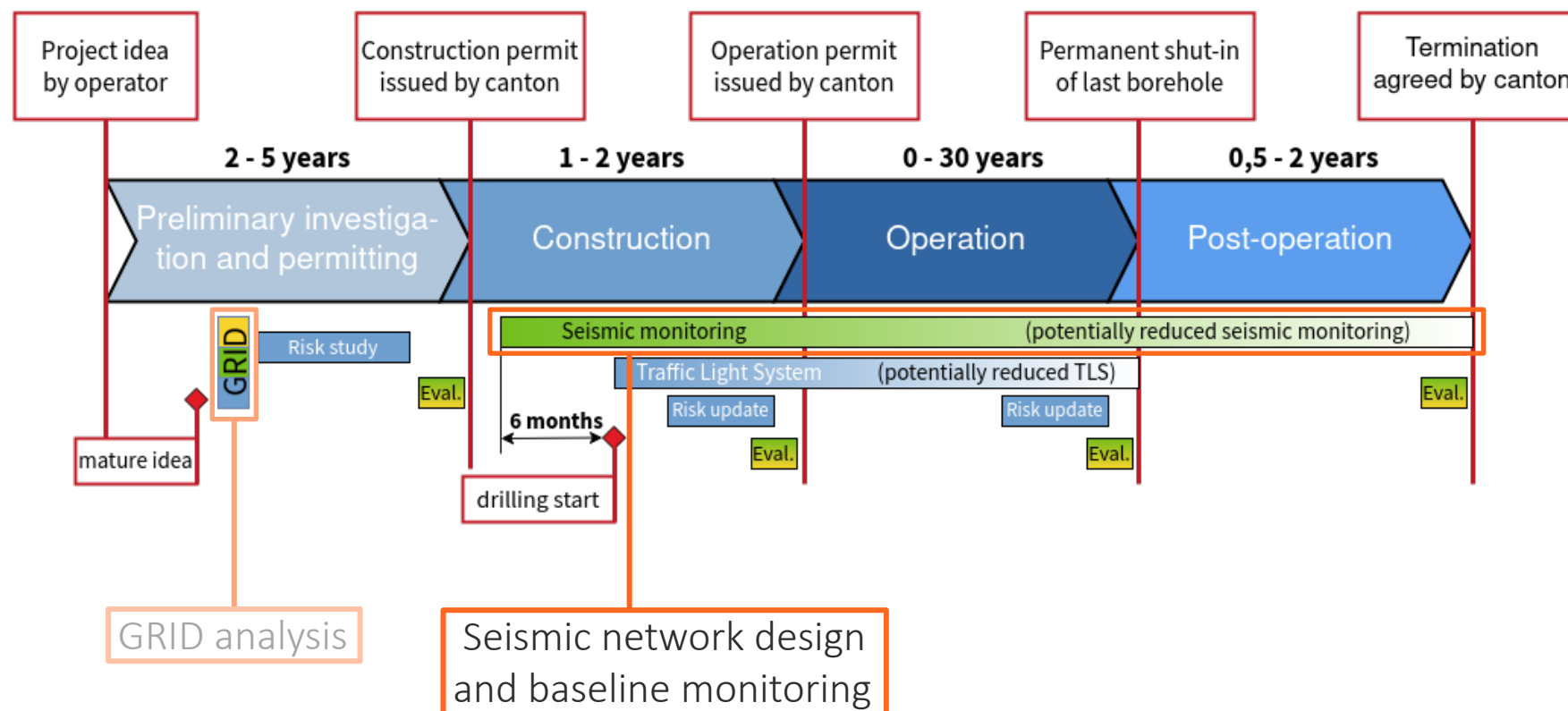
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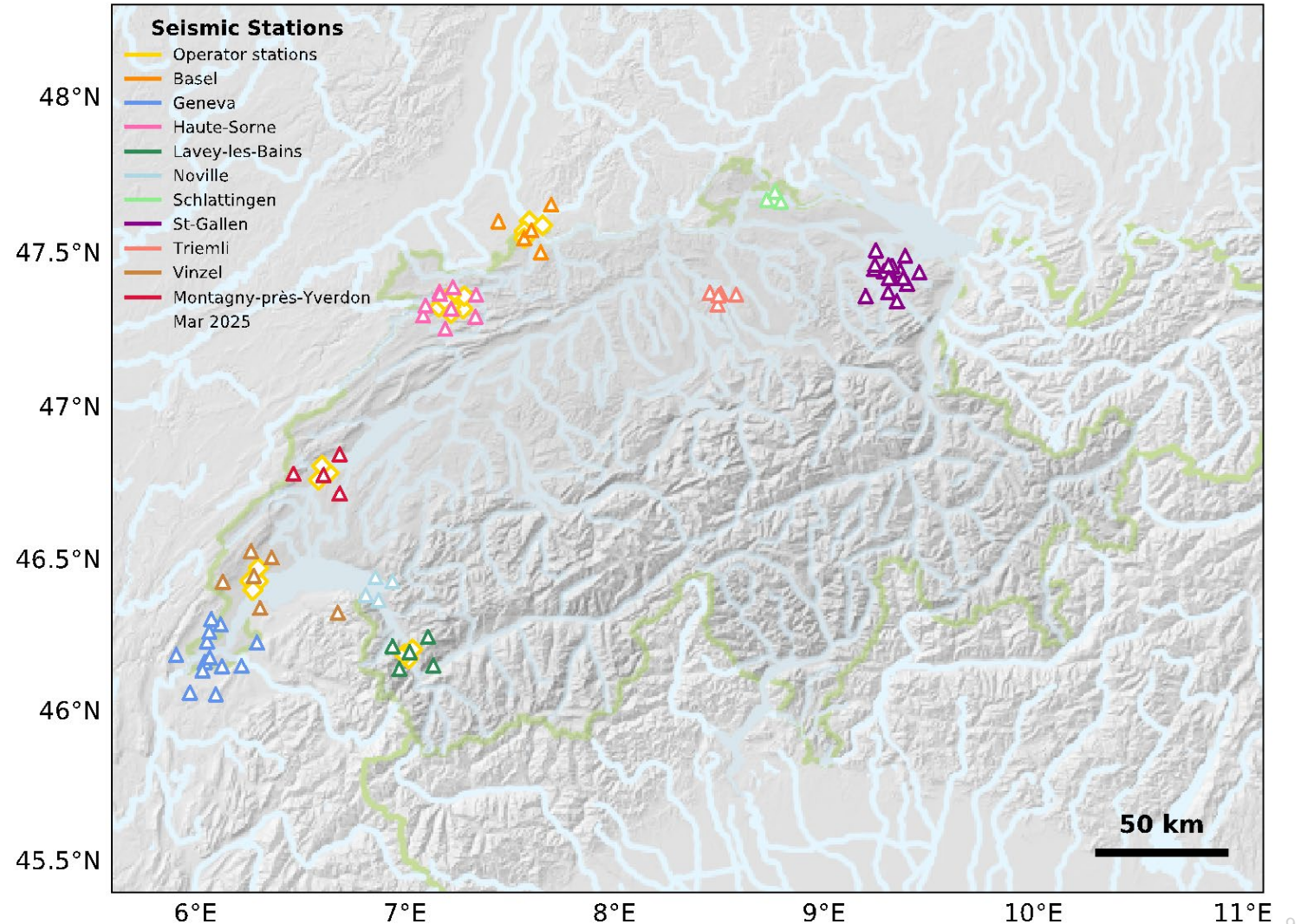
# Network design & baseline monitoring

## *Specific seismic networks for the baseline monitoring of each project*

Since 2010, GEOBEST has been monitoring all deep geothermal projects in Switzerland.

Using the national network as a backbone, GEOBEST locally densifies the seismic network with semi-permanent stations to increase earthquake detectability and location precision around deep geothermal projects.

The baseline specific network can be supplemented by additional operator stations (◊)

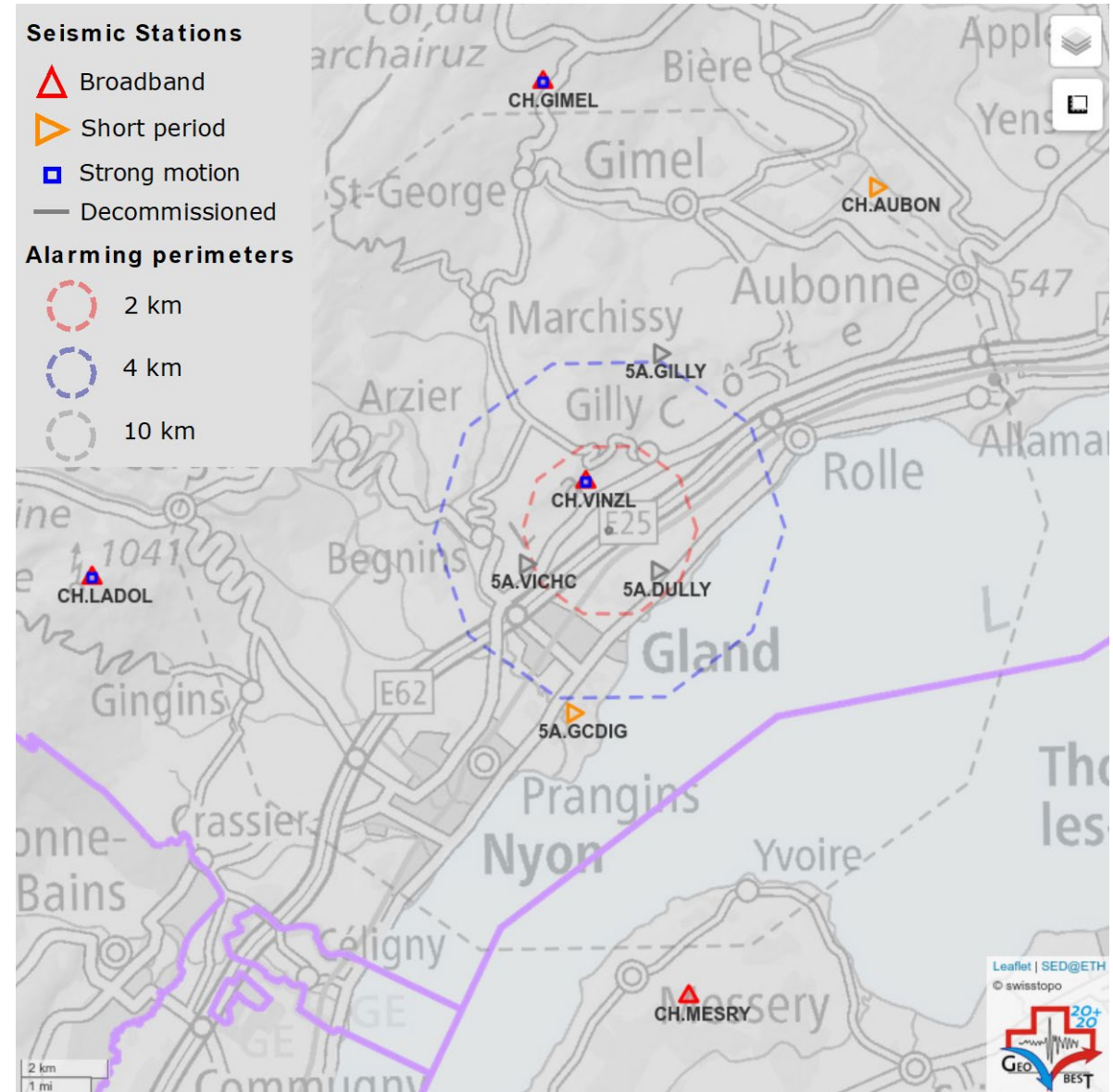


# Network design, baseline monitoring & alarming

## Example of the EnergieÖ – Vinzel project

Relying on the backbone of the national network, four semi-permanent stations were deployed between 2019 and 2021 (MESRY, VINZL, LADOL and AUBON).

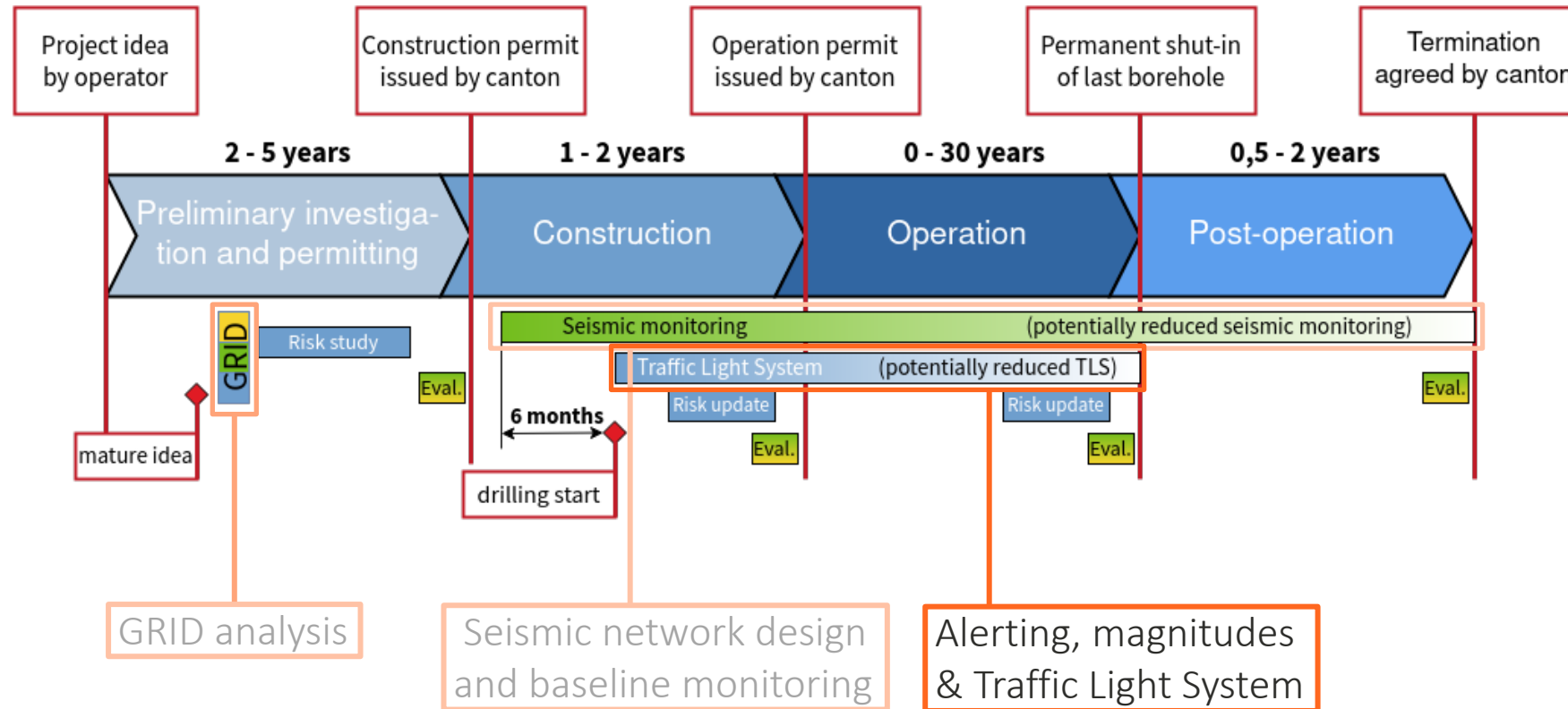
Additional operator stations are integrated by the SED into the real-time system and archiving (data released after a 5 years embargo).



# The GEOBEST workflow

*Seismological consulting and expertise throughout the life-cycle of a geothermal project*

Actors:  
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# Alarming, location/magnitudes and TLS

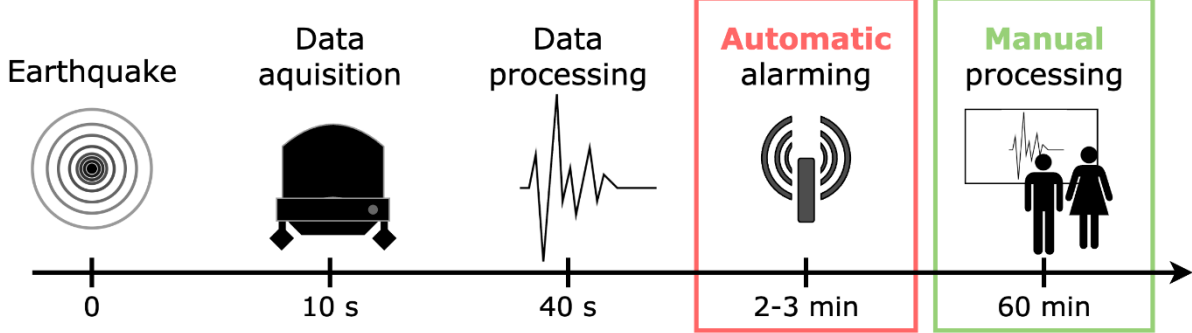
*SED magnitudes and location are authoritative*

The **Swiss Seismological Service** provides round the clock alarms during critical phases of the geothermal projects

Alarm	Distribution	Perimeter	Magnitude thresholds
notfelt-auto	SED only	4 km	generally $M_{Lhc} < 1,5$
notfelt-manu	TECH list	2 km	generally $M_{Lhc} < 1,5$
felt	COMM list	4 km	generally $M_{Lhc} \geq 1,5$
distant-felt	COMM list	20 km	generally $M_{Lhc} \geq 4$

The running of the Traffic Light System is the responsibility of the operator.

## Timeline of felt alarm





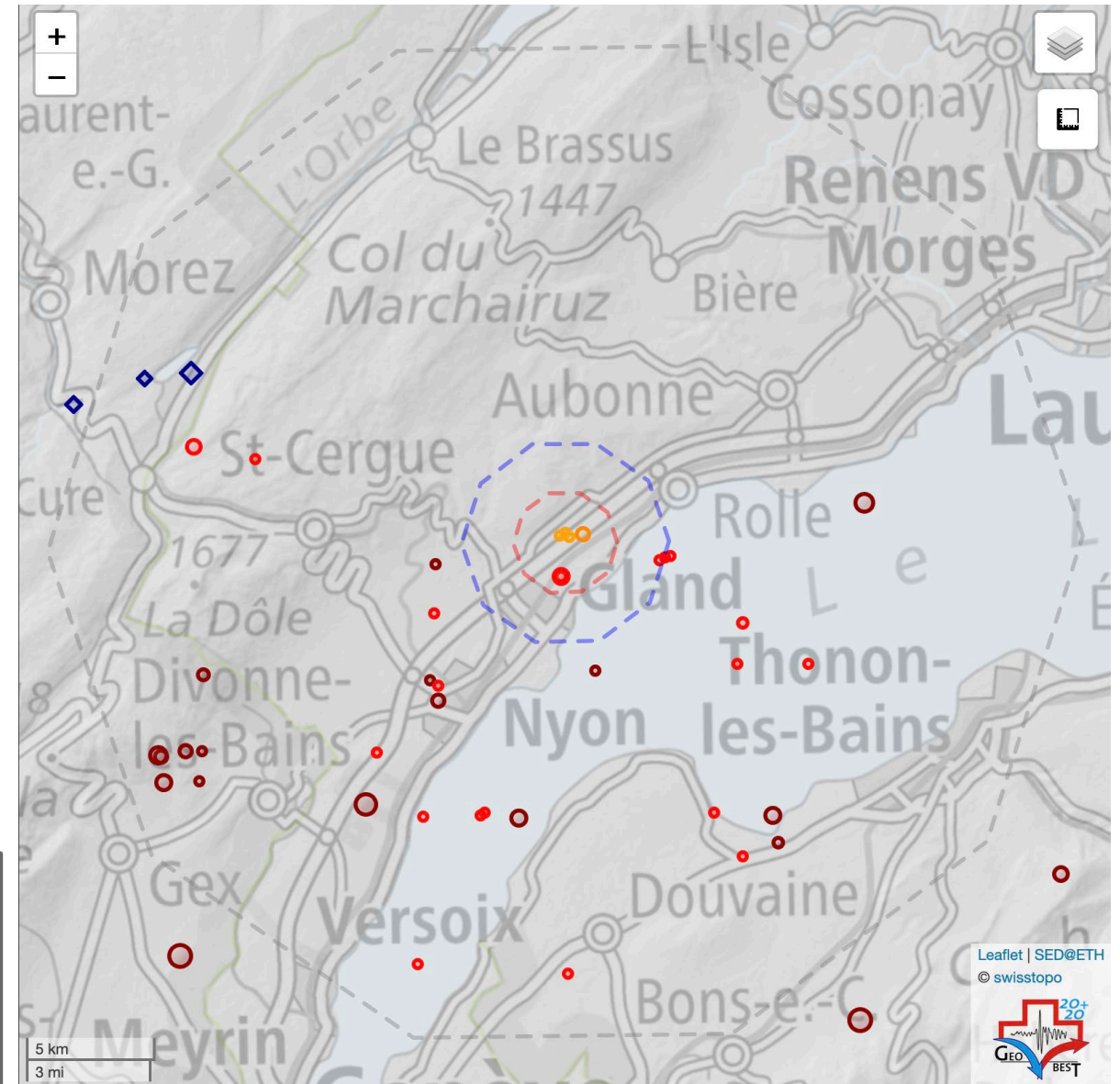
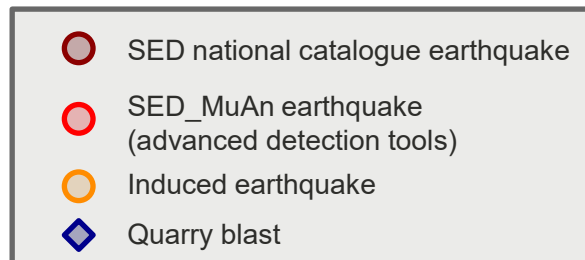
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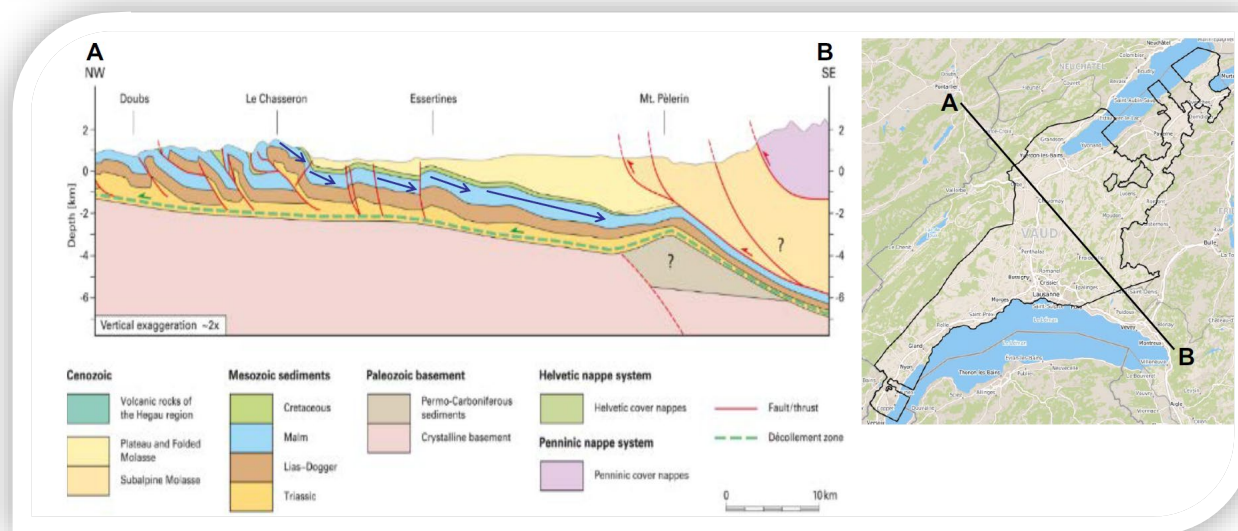
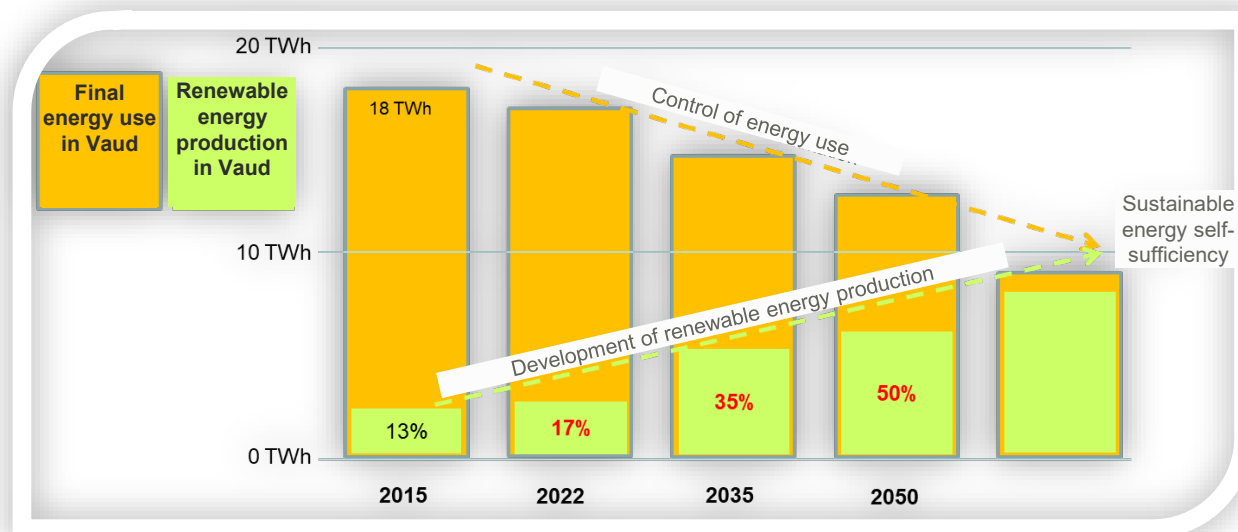
Seismicity recorded in Vinzel since October 2019



# Geothermal energy in the Canton Vaud

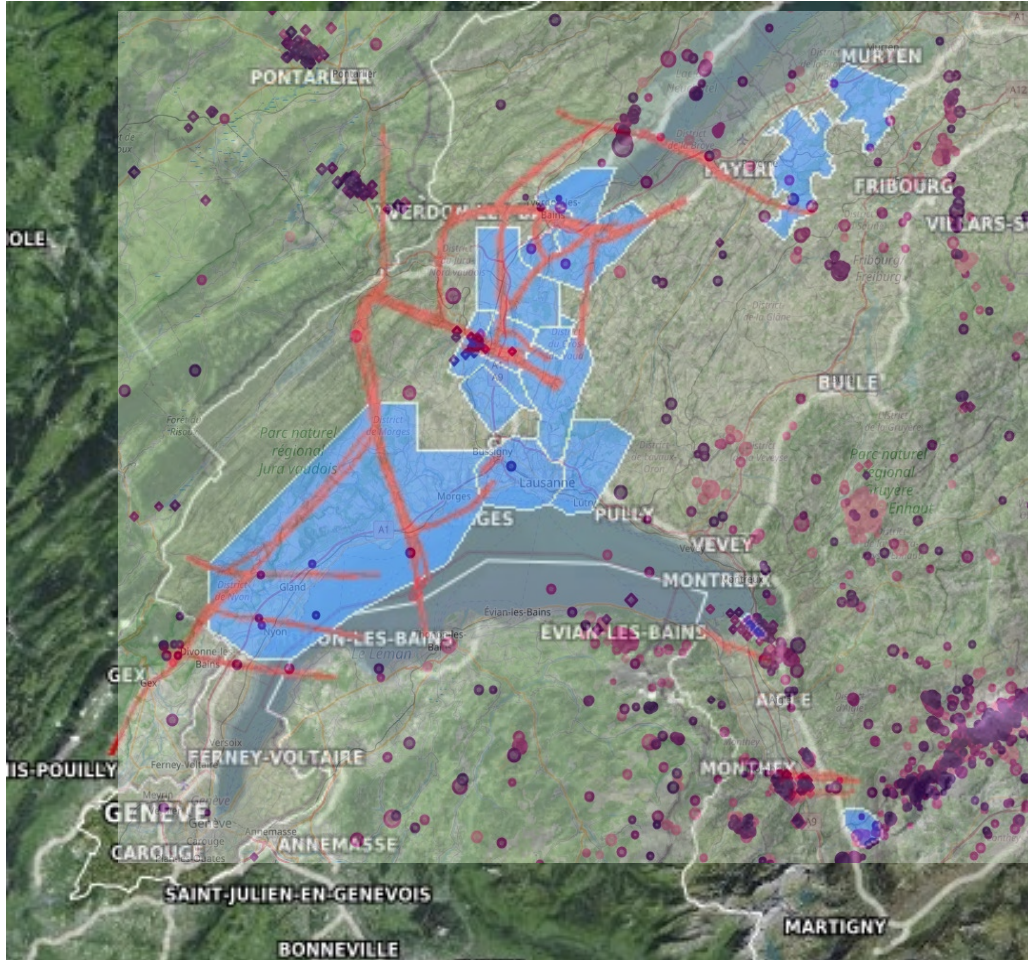
## How to get the carbon neutrality in 2050 ?

- ✦ Decrease in the energy use, **increase in the part of renewable energies** in the energetic mix
- ✦ All the local and renewable resources : important role to play
- ✦ Favourable geological context, high potential for geothermal energy : **the resources of the subsurface are at the heart of the energy transition**
- ✦ **Lack of subsurface knowledge** : slow projects development ...



# Deep geothermal projects

*What is the current state of deep geothermal energy?*



- ✦ In 5 years, **a lot of projects in development** : 14 permits for geophysical exploration and 3 for deep wells delivered
- ✦ **Mainly hydrothermal projects** for heat production, targeting the main **regional faults**, location of deep water flow
- ✦ Two projects for cogeneration (heat and electricity)
- ✦ **Low to moderate seismicity** in Canton Vaud (activity recorded close to the regional faults)
- ✦ **National monitoring network insufficient** to ensure adequate monitoring of geothermal projects

*What is the cantonal framework for project development ?*

## Law on the natural subsurface resources (LRNSS, 2018)

*For a durable, rational, efficient and environmentally aware subsurface exploitation  
Regulation, definition roles and responsibilities*



### PROJECT DEVELOPER

- ☐ Holder of permit or concession
- ☐ Responsible for their works
- ☐ Ensure security, monitoring and maintenance of the wells



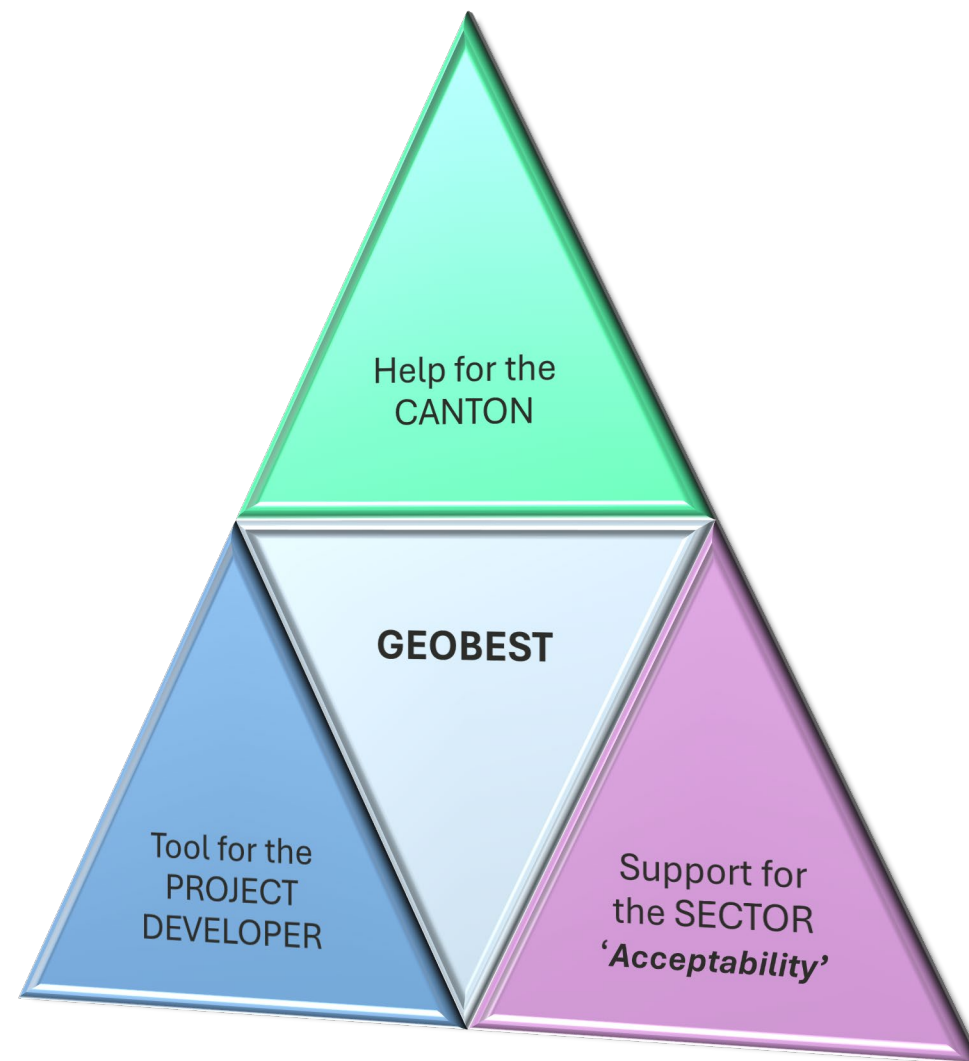
### CANTONAL AUTHORITIES

- ☐ Owner of the subsurface resources
- ☐ Deliver the permit or concession
- ☐ Check of the environmental impacts and risks (legal framework)
- ☐ Ensure the « haute surveillance » (regulatory oversight) with the help of external experts

# GEOBEST in the Canton Vaud

## Why has the canton of Vaud chosen GEOBEST?

- ✦ **Maximum level of precaution required** : lack of subsurface knowledge ; priority is given to learn, understand and anticipate induced seismicity
- ✦ **Independent monitoring** from competent federal institute
- ✦ **External expertise** for project regulation, haute surveillance (regulatory oversight) and acceptability
- ✦ **Transparency of the information** and real-time communication
- ✦ **Compliance with the cantonal legal framework** in terms of role and responsibilities:
  - ✓ **SED** : focus on the “safety of property, people and environment” level to help the canton for regulation and haute surveillance (regulatory oversight)
  - ✓ **Project developer** : focus on “operations management, security and monitoring of their works and wells”

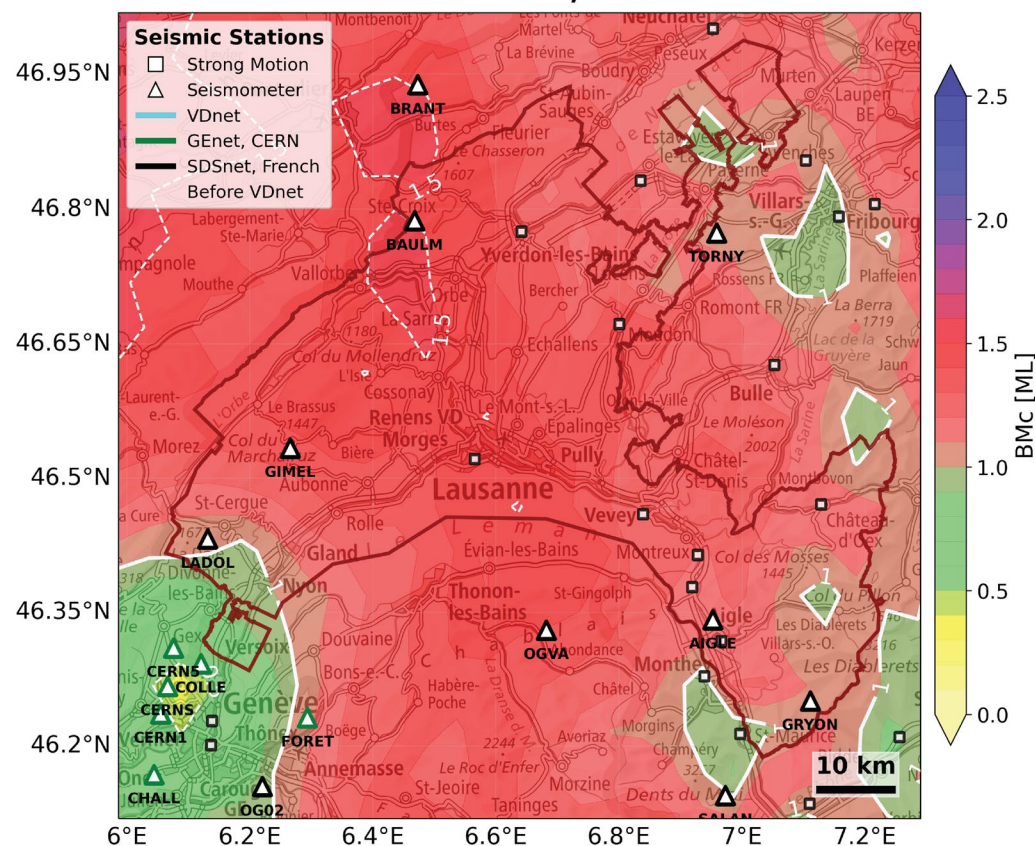




# Conclusions and perspectives

## What is the next for GEOBEST ?

### Permanent network, **before** VDnet



- **GEOBEST, a crucial but temporary program !**
- GEOBEST is a springboard and gives the opportunity to develop geothermal projects in a climate of trust and transparency with regard to seismicity.
- The challenge for the Canton Vaud is now to continue in this dynamic on the long-term.
- It is the reason why the **Canton Vaud** is taking the hand on the seismic monitoring of their territory with the support of the Confederation and SED in developing **VDnet**.
- **VDnet** is an improved cantonal network, included in the seismic national monitoring.
- **VDnet is a positive consequence of GEOBEST.**



# Conclusions and perspectives

## *Is GEOBEST having an impact ?*



- **The collaboration is effective.** VD and the SED paved the way and set a sound workflow for regulatory oversight in the field of induced seismicity for geothermal projects.
- **Good uptake:** GEOBEST adopted by 7 cantons since 2023.
- **The GEOBEST Team** is working on recommendations for the monitoring and mitigation of induced seismicity during the **post-exploration and concession phases**.

We are looking to hear about your expertise and feedback on past/present projects outside Switzerland!

- **Advanced cantons** are taking the hand on the seismic monitoring of their territory with the support of the Confederation.
- **The future of GEOBEST ?**



## Questions?

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