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

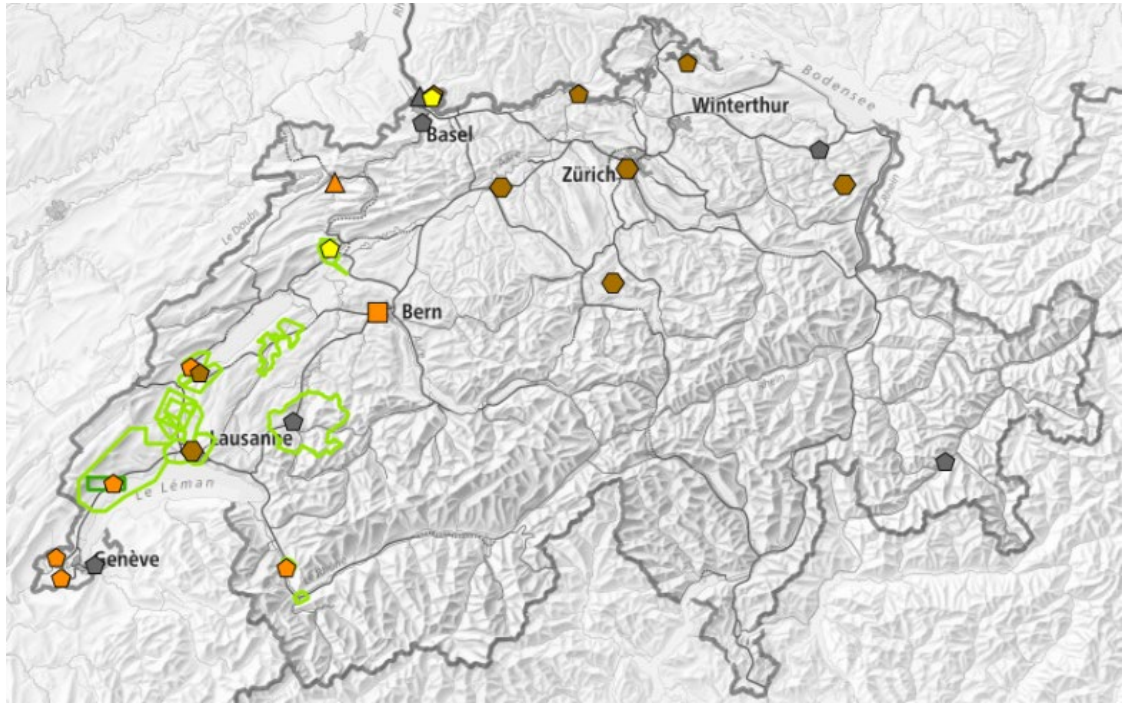
Schweizerischer Erdbebendienst
Service Sismologique Suisse
Servizio Sismico Svizzero
Swiss Seismological Service

canton de vaud
LIBERTÉ ET PATRIE

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

Legend

Status
- Prospection
- Under development
- In operation
- Abandoned

System
- Deep geothermal probe
- Hydrothermal
- Enhanced geothermal system (EGS)
- High temperature aquifer thermal energy storage (HT-ATES)

Permit
- Permit for subsurface exploration
- Permit for prospection from the surface

- 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**.

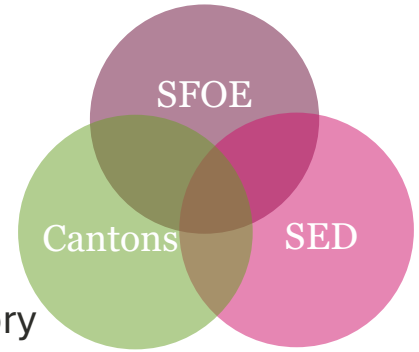
Why GEOBEST ?

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**

CH GEO BEST



Harmonised practices

➢ **Improved competencies of projects regulators and developers**

➢ **Improved safety**

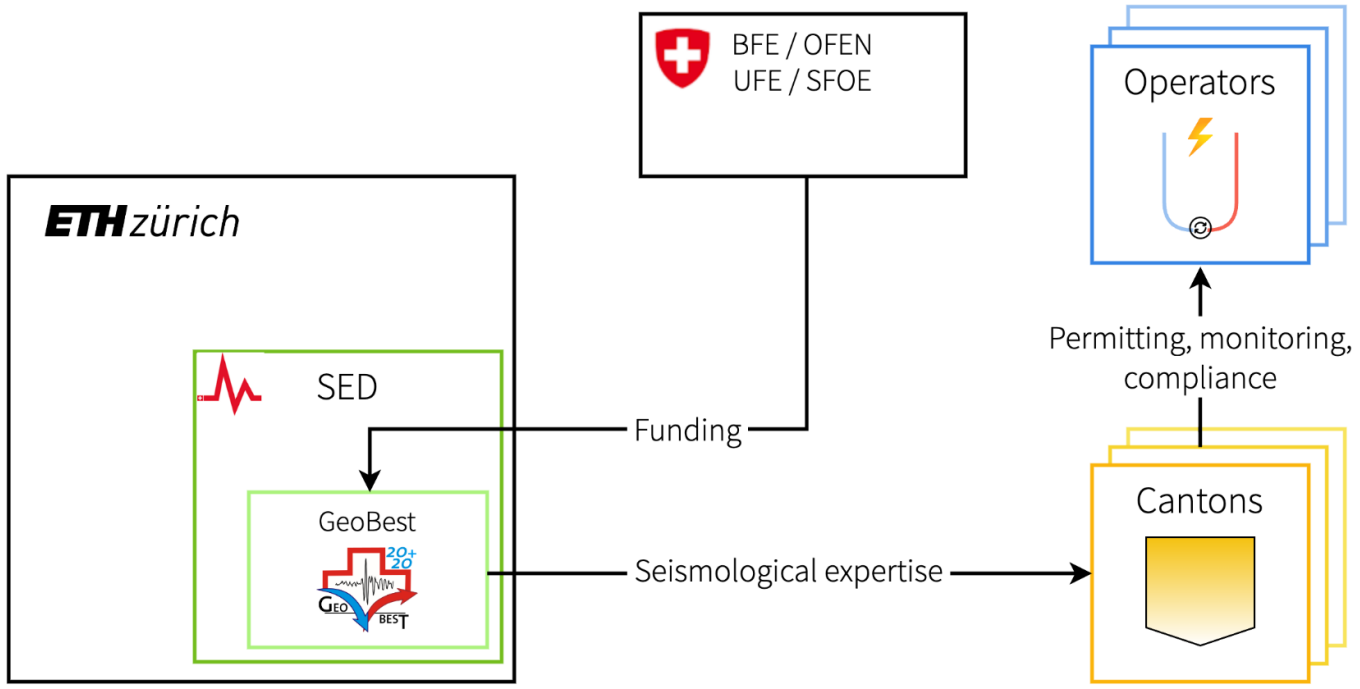
➢ **Supporting sustainable growth of geothermal development**

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:

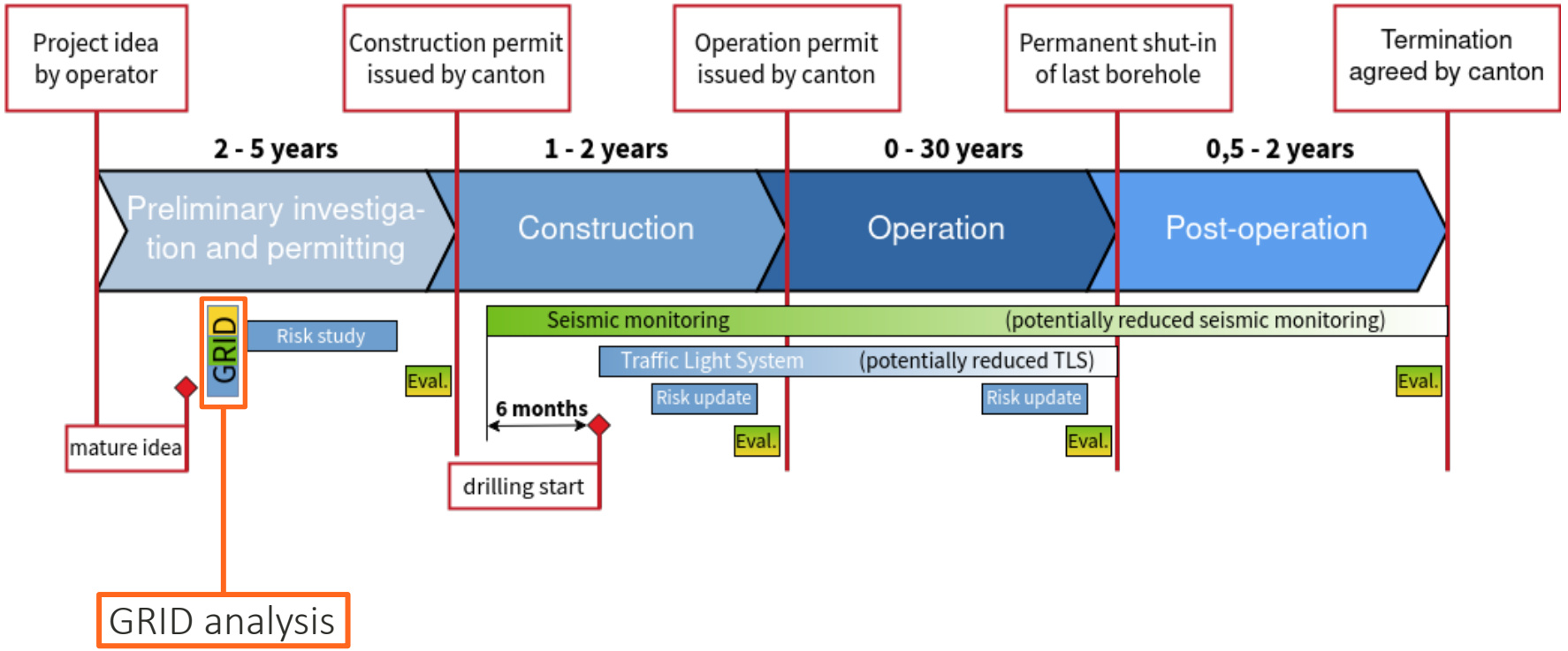
- Seismic monitoring and alerting for deep geothermal projects using the know-how of SED
  - Infrastructure for real-time alerting
  - Pool of instruments for parallel monitoring of several projects
- Seismological consulting on induced seismicity and the assessment of hazard and risk studies.
- Promotion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



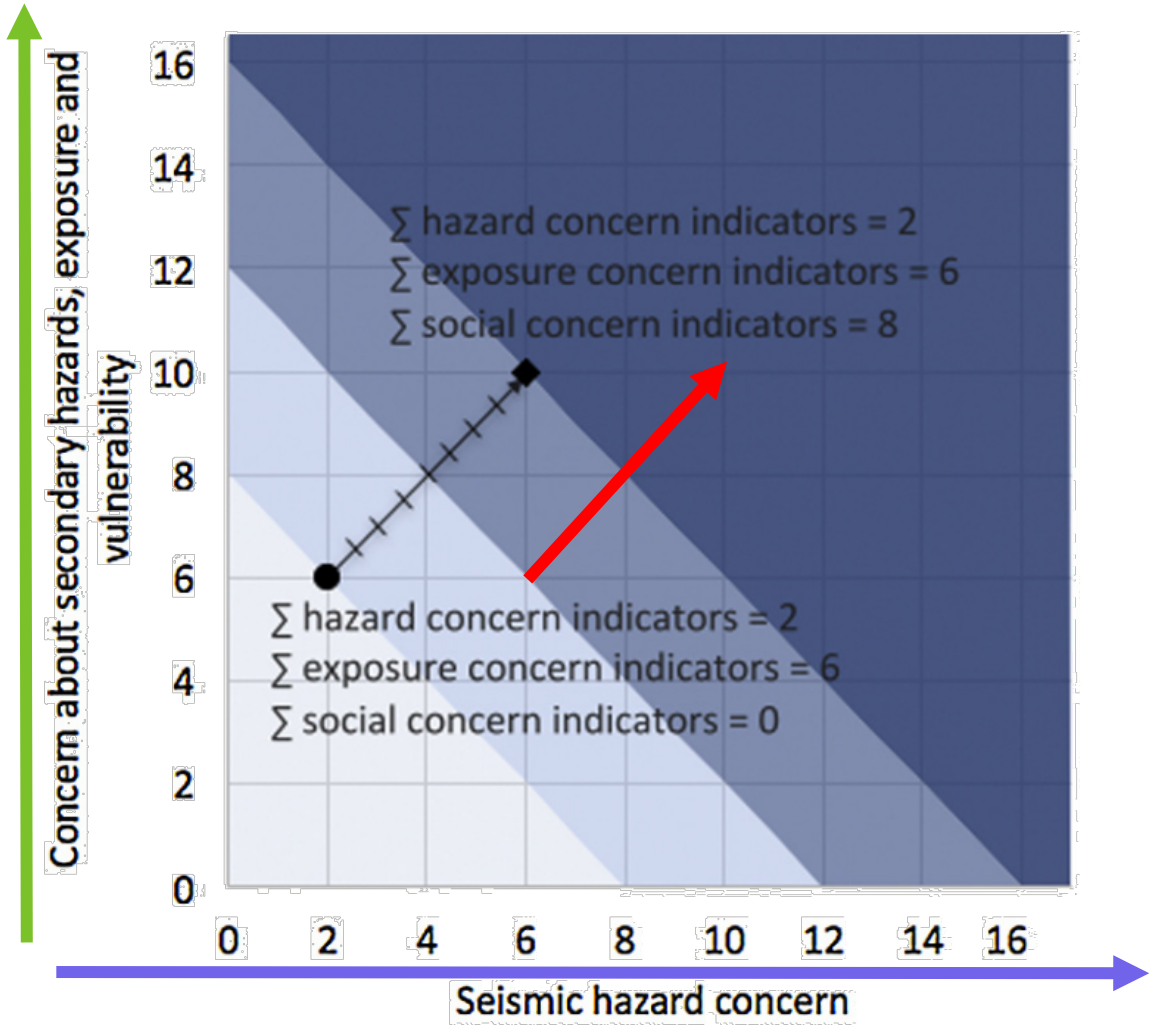
GRID: **G**eothermal **R**isk of **I**nduced Seismicity **D**iagnosis

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**

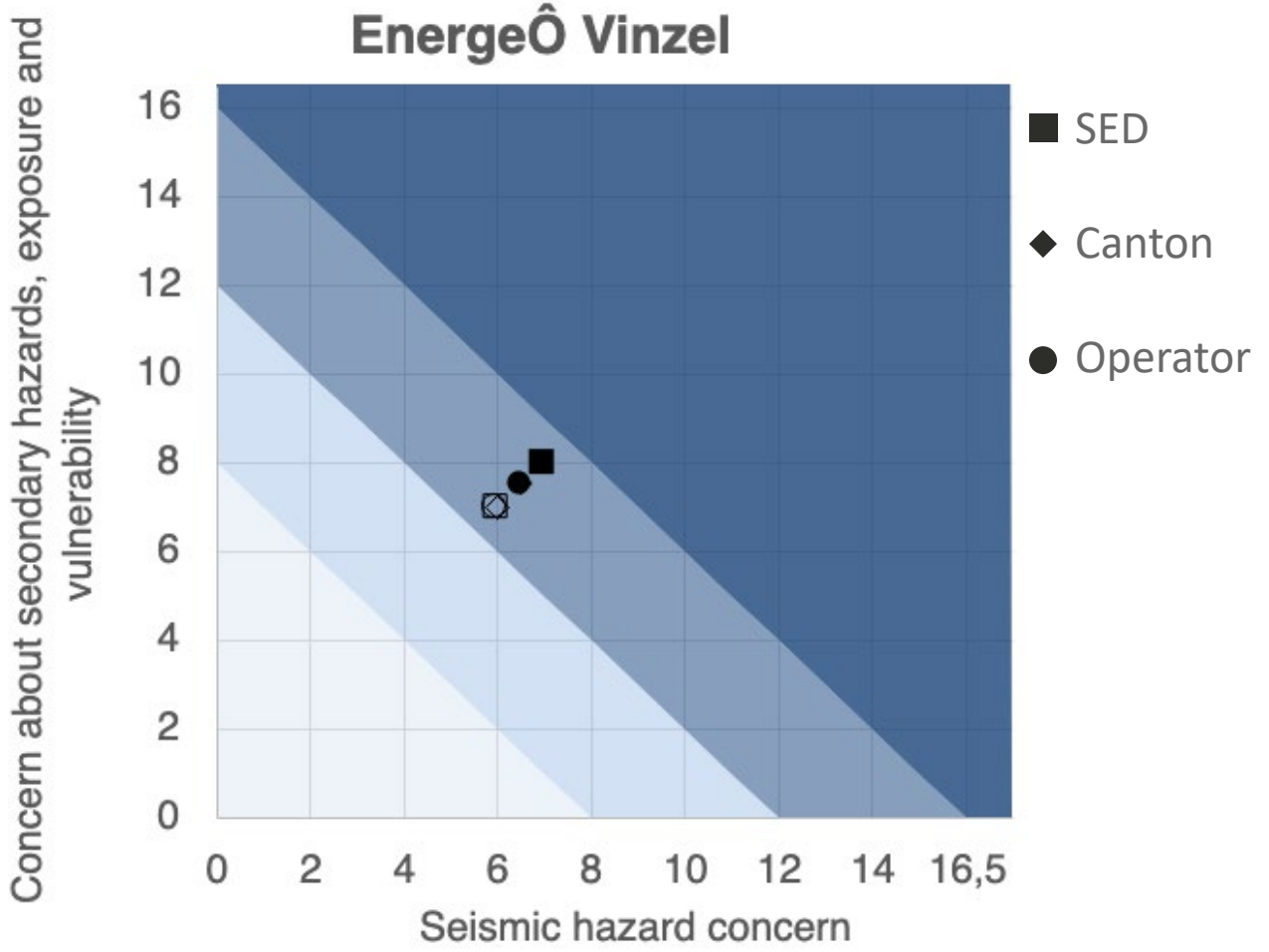


GRID: **G**eothermal **R**isk of **I**nduced Seismicity **D**iagnosis

Example of the EnergeÔ – 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



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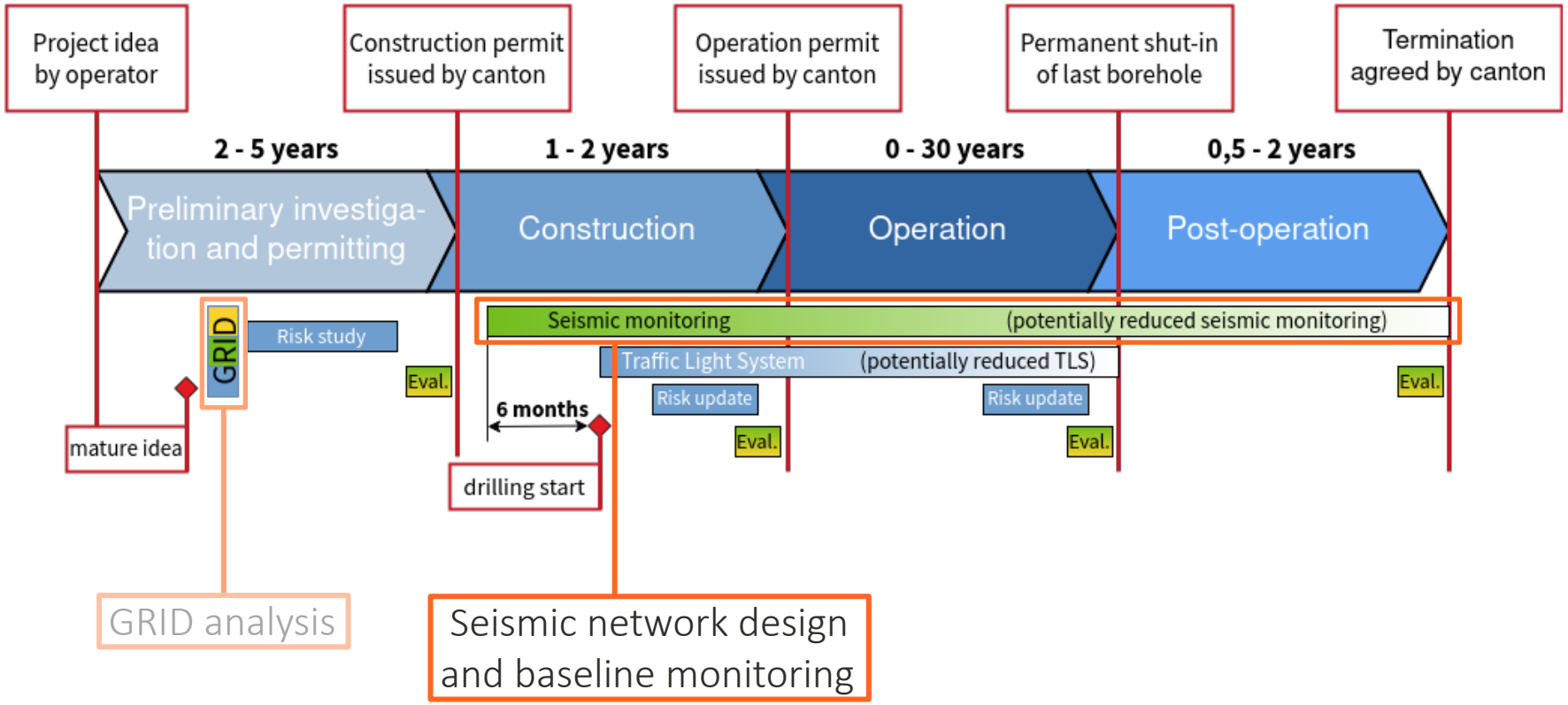


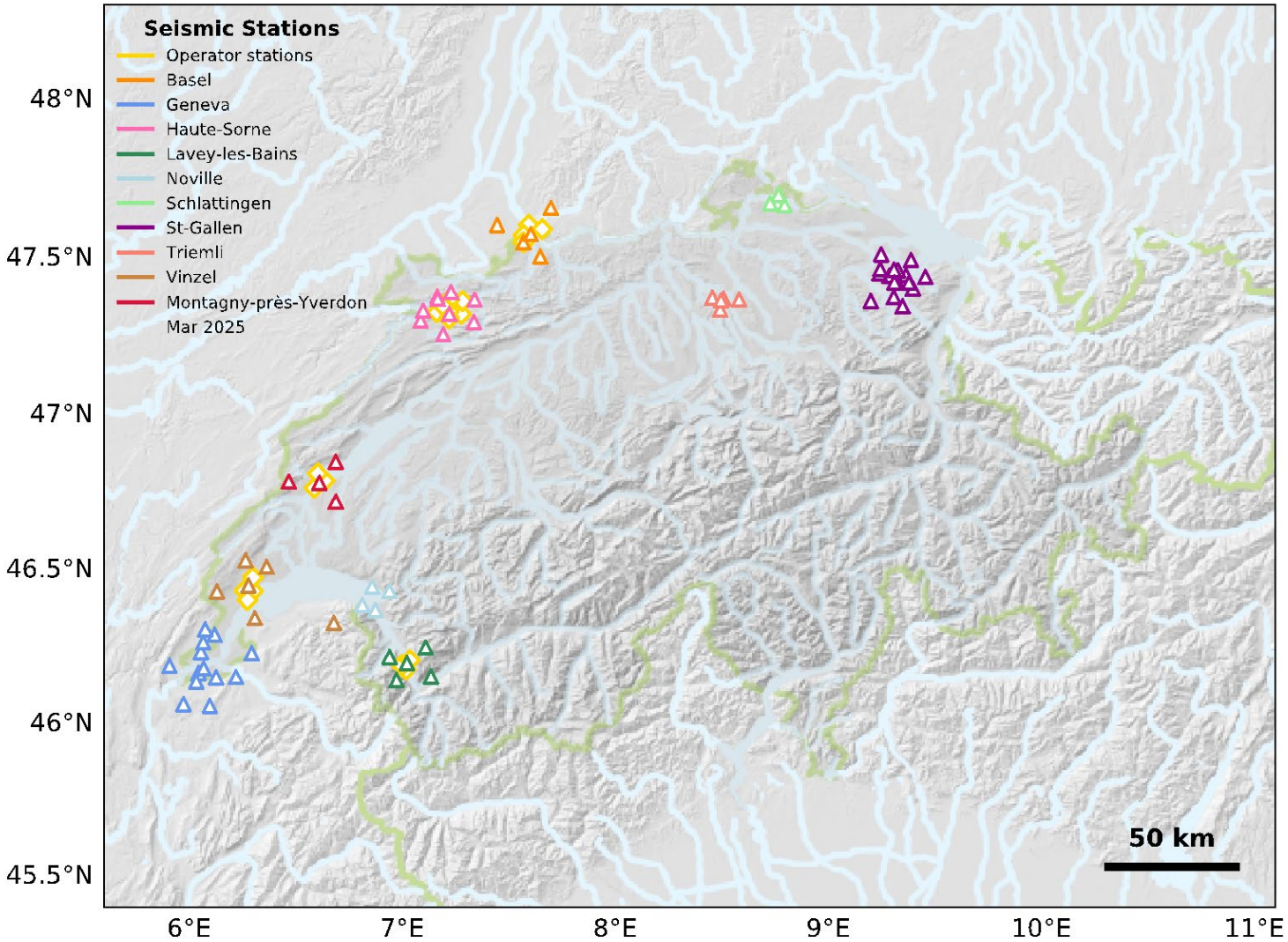
Network design & baseline monitoring

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 (◇)

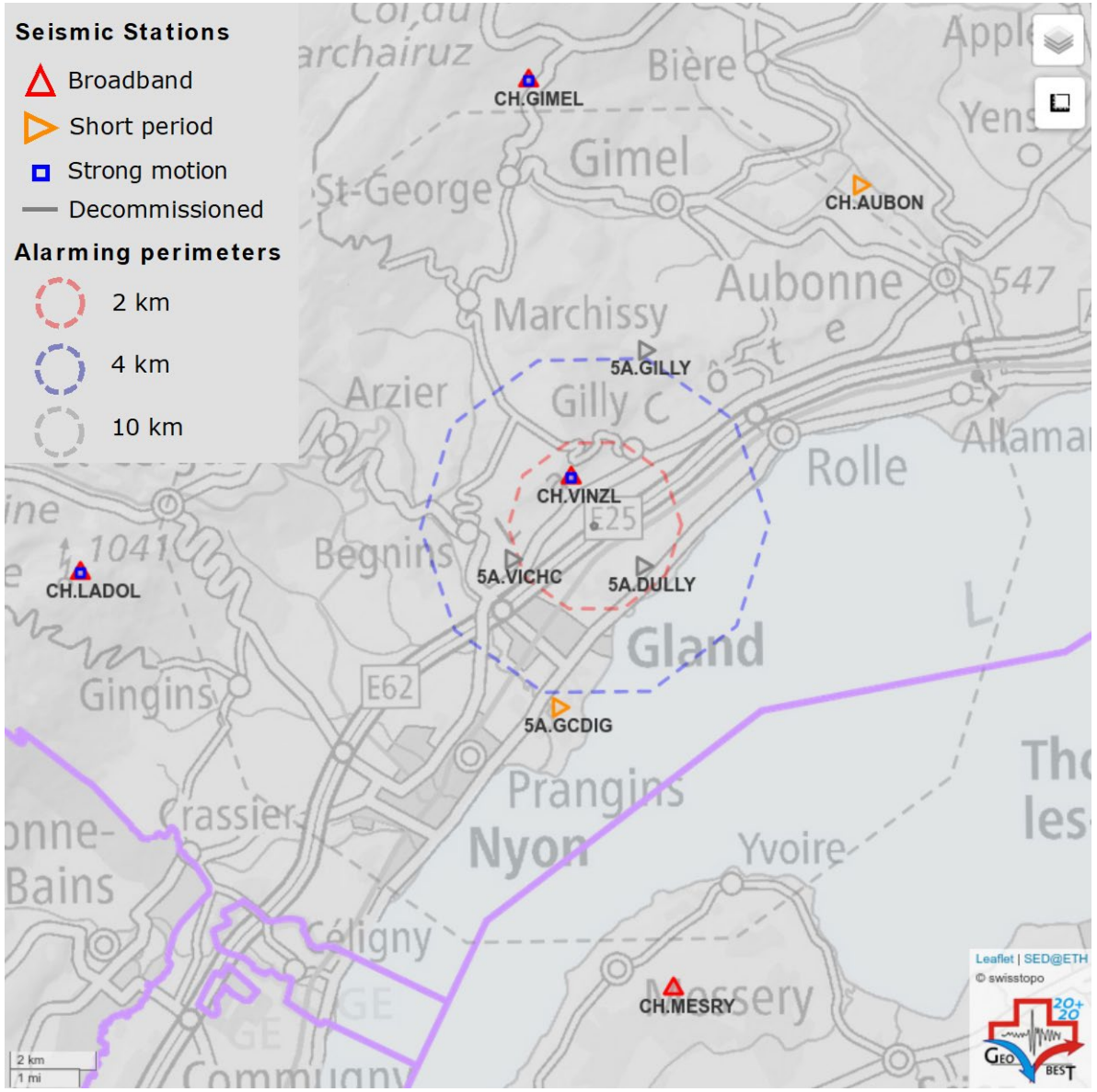


Network design, baseline monitoring & alarming

Example of the EnergeÔ – 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).



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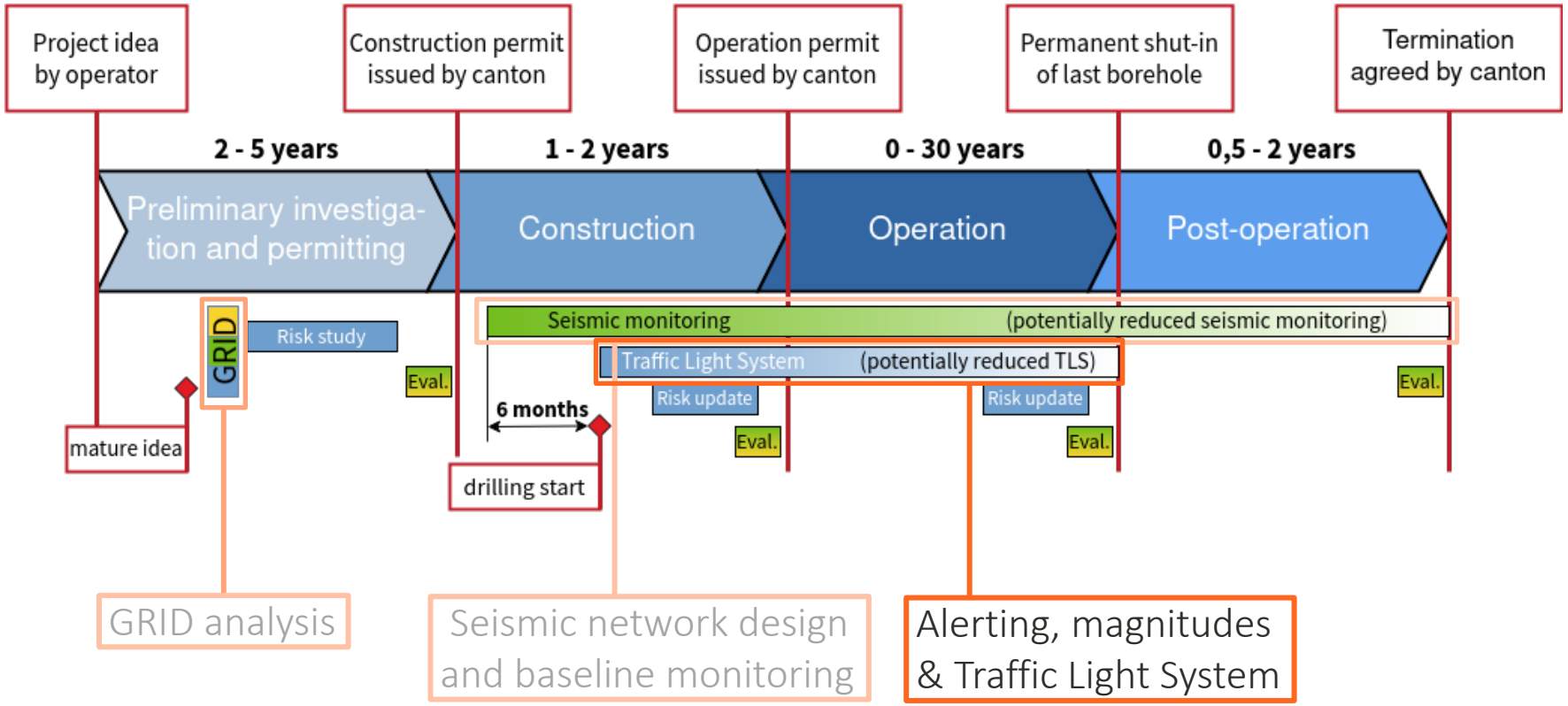


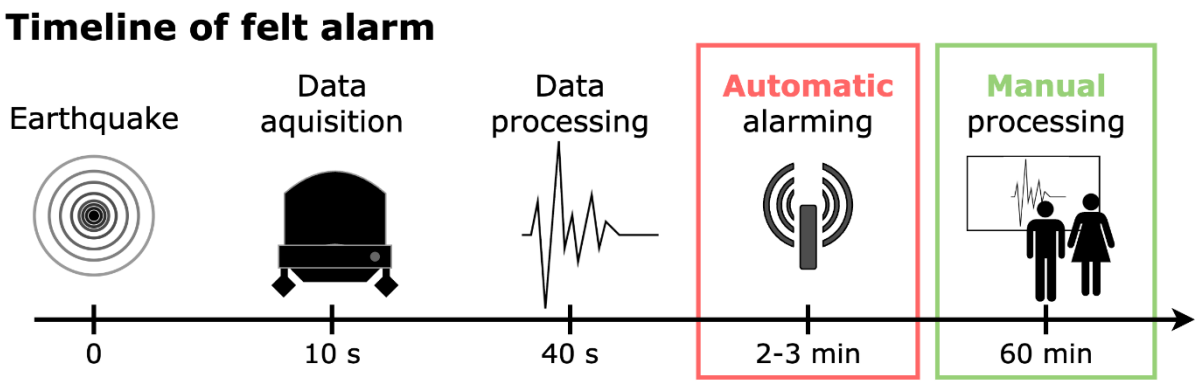
Alarming, location/magnitudes and TLS

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.



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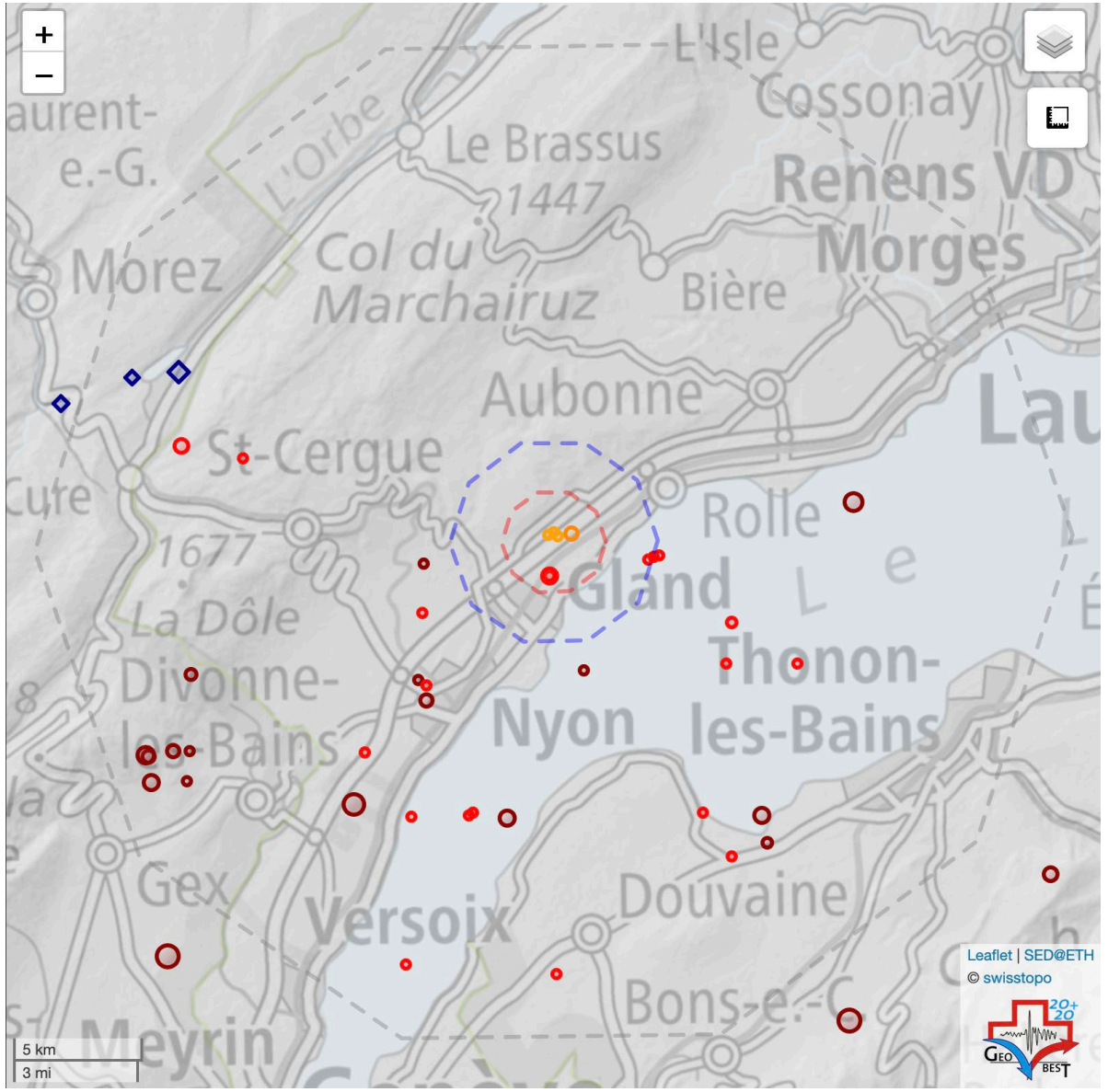
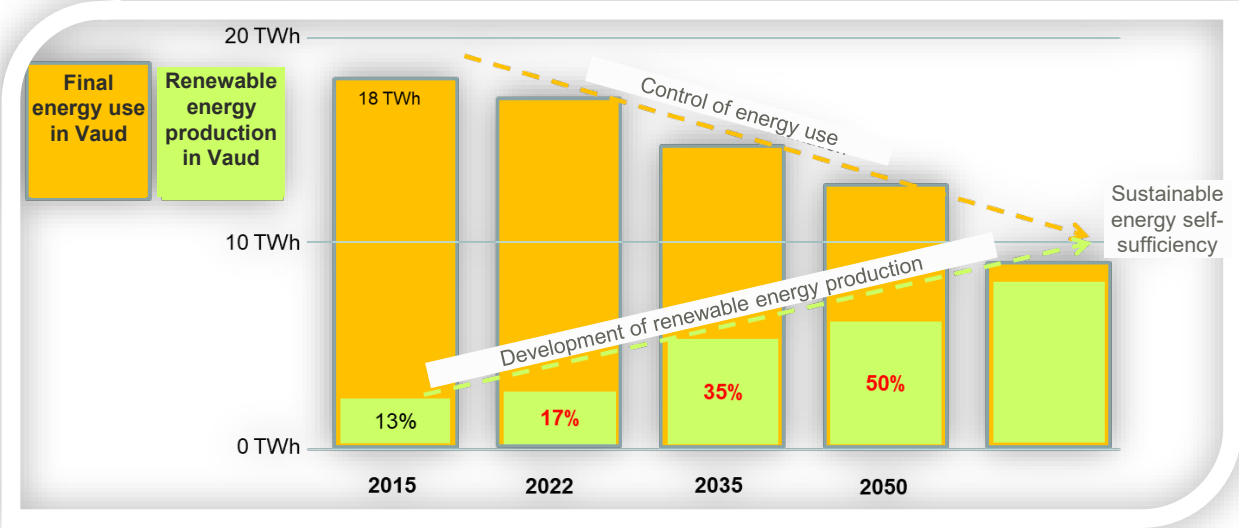


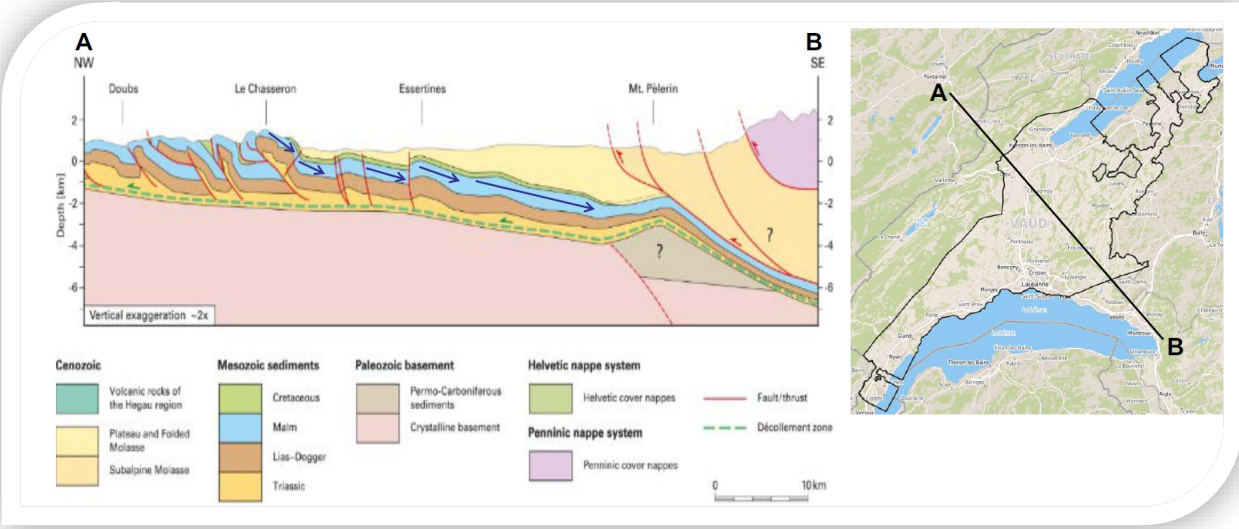
Seismicity recorded in Vinzel since October 2019

Geothermal energy in the Canton Vaud

How to get the carbon neutrality in 2050 ?

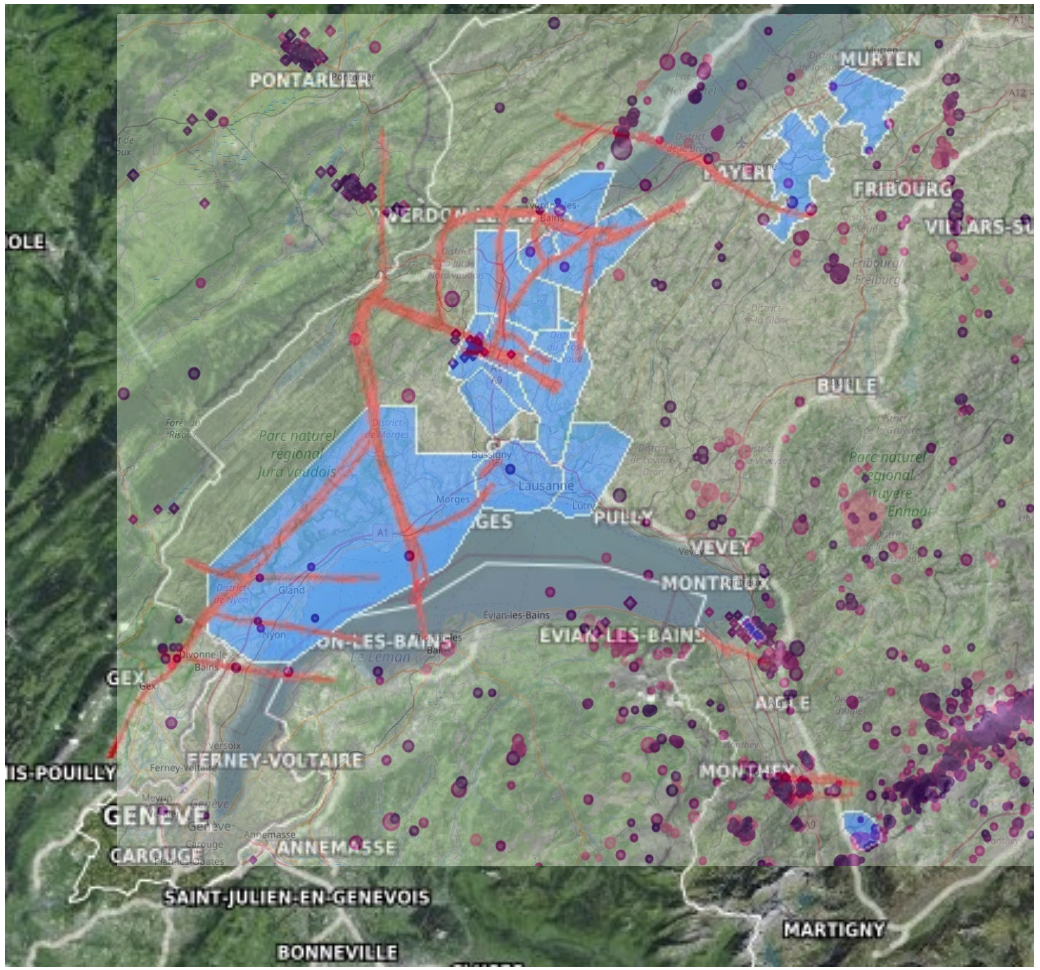
- Decrease in the energy use, **increase in the part of renewable energies** in the energetic mix
- All the local and renewable resources : important role to play
- Favourable geological context,high potential for geothermal energy : **the resources of the subsurface are at the heart of the energy transition**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

Regulation

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

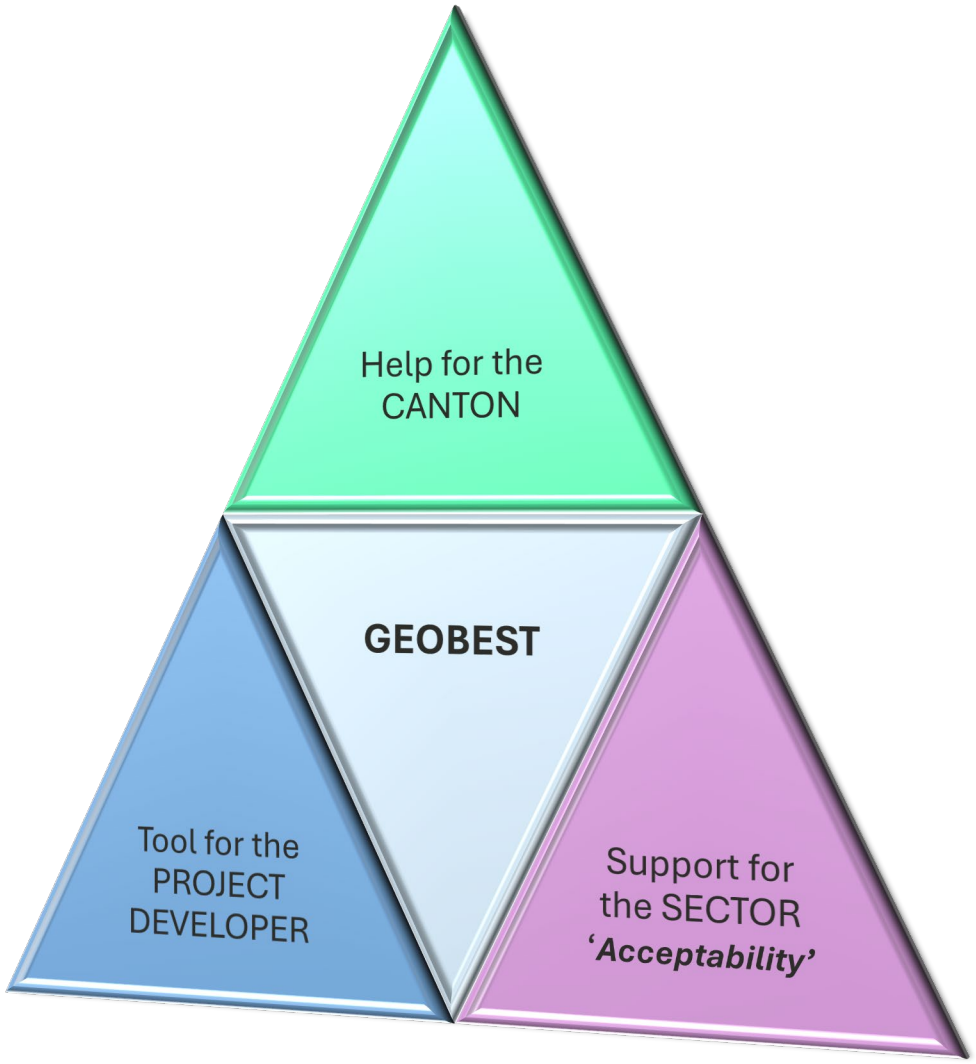
GEOBEST in the Canton Vaud

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:

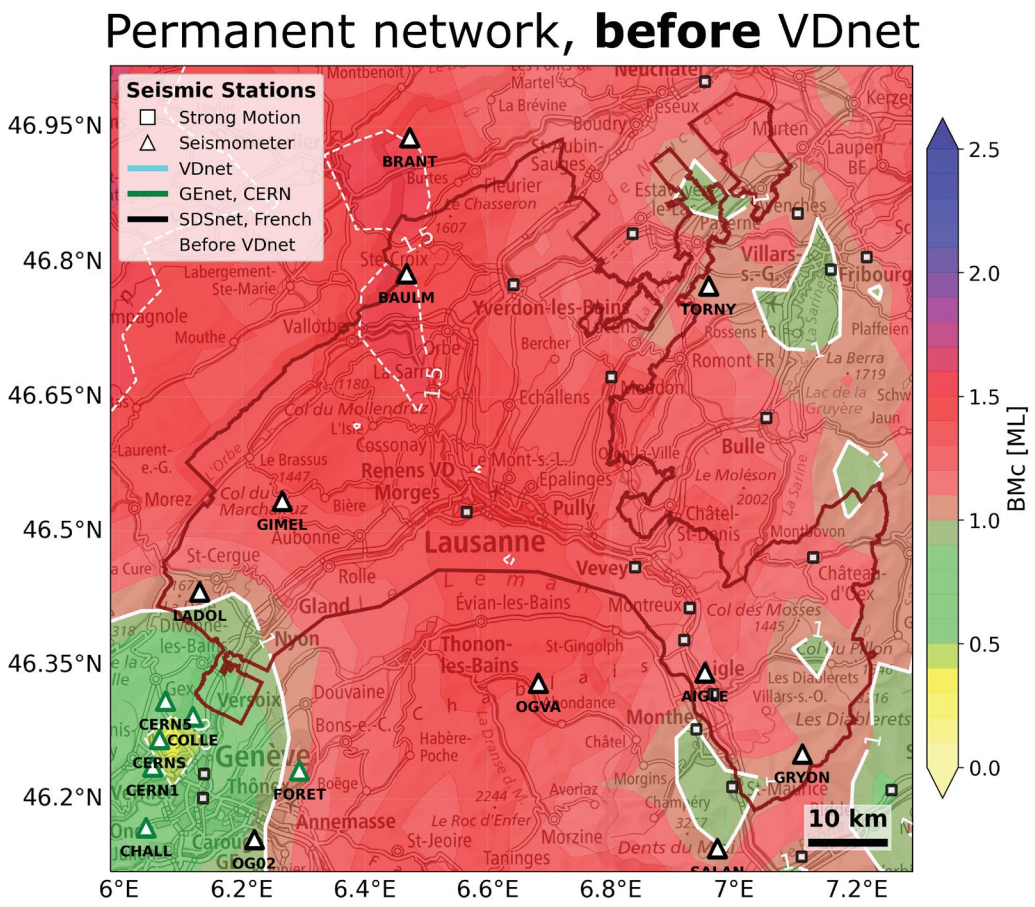
✓ ***SED*** *: focus on the "safety of property, people and environment" level to help the canton for regulation and haute surveillance (regulatory oversight)*

✓ ***Project developer*** *: focus on "operations management, security and monitoring of their works and wells"*



Conclusions and perspectives

What is the next for GEOBEST ?



- **GEOBEST, a crucial but temporary program !**
- GEOBEST is a springboard and gives the opportunity to developpe 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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