

Symposium 2023 – 21st November 2023

Taking the miniRuedi to the (shaking) spa

... Is this guy getting free entrances at the spa ?

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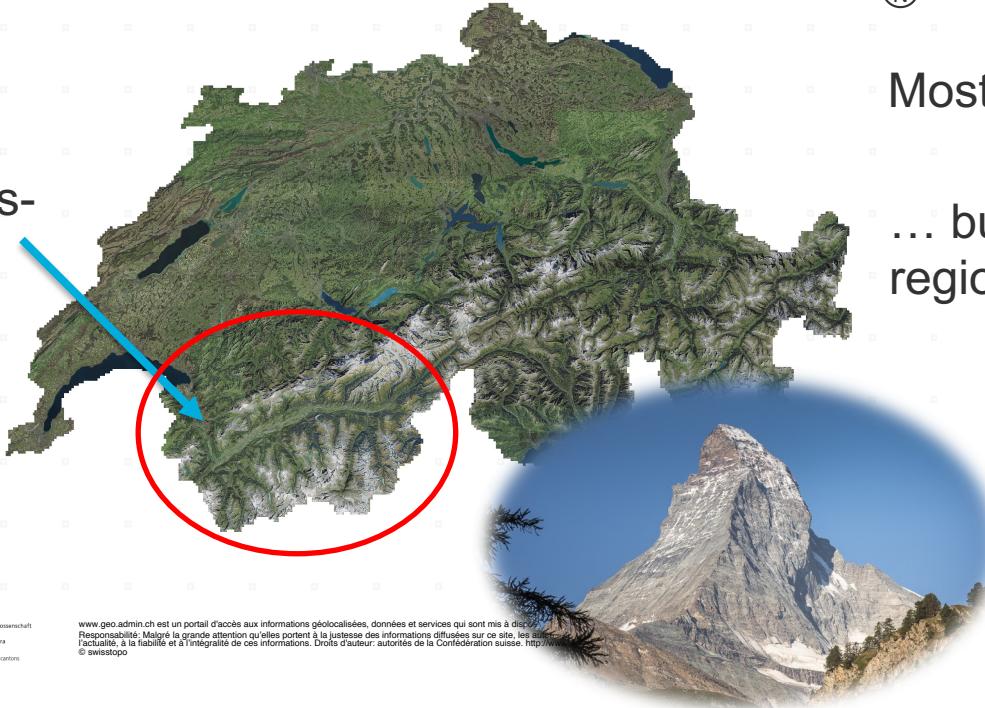
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1. Wallis – He Mapping

Lavey-les-Bains



Most beautiful canton of Switzerland

... but also one of the most seismic region of Switzerland



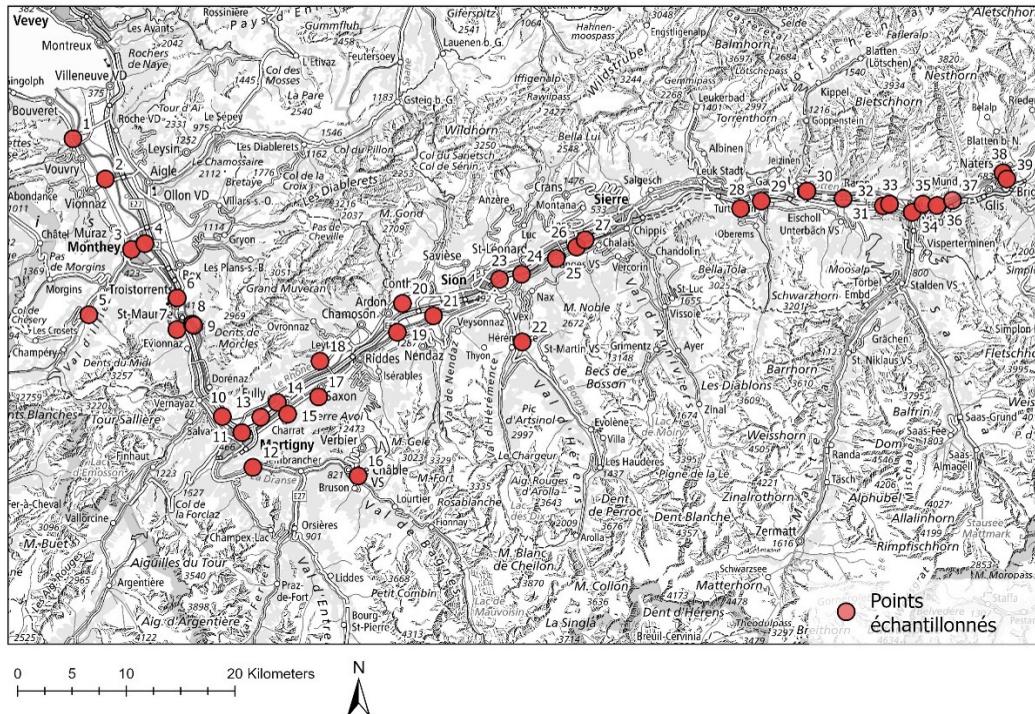
1. Wallis – He Mapping



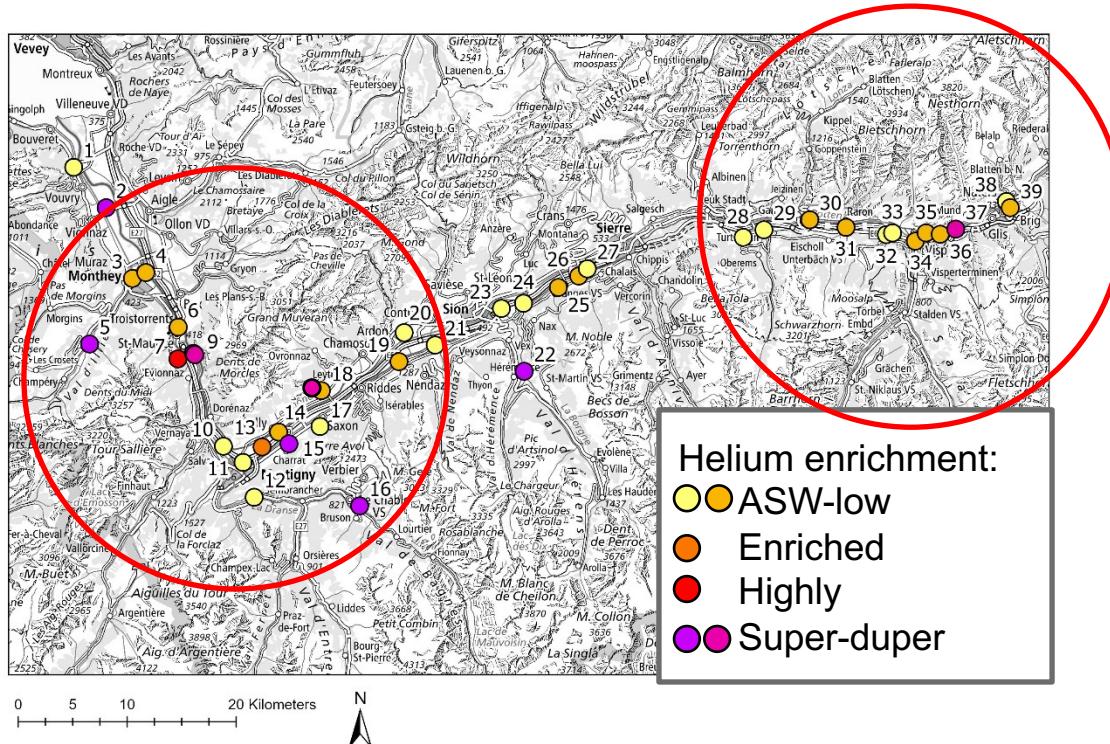
The miniRuedi Car

Next step: self-driving car

1. Wallis – He Mapping



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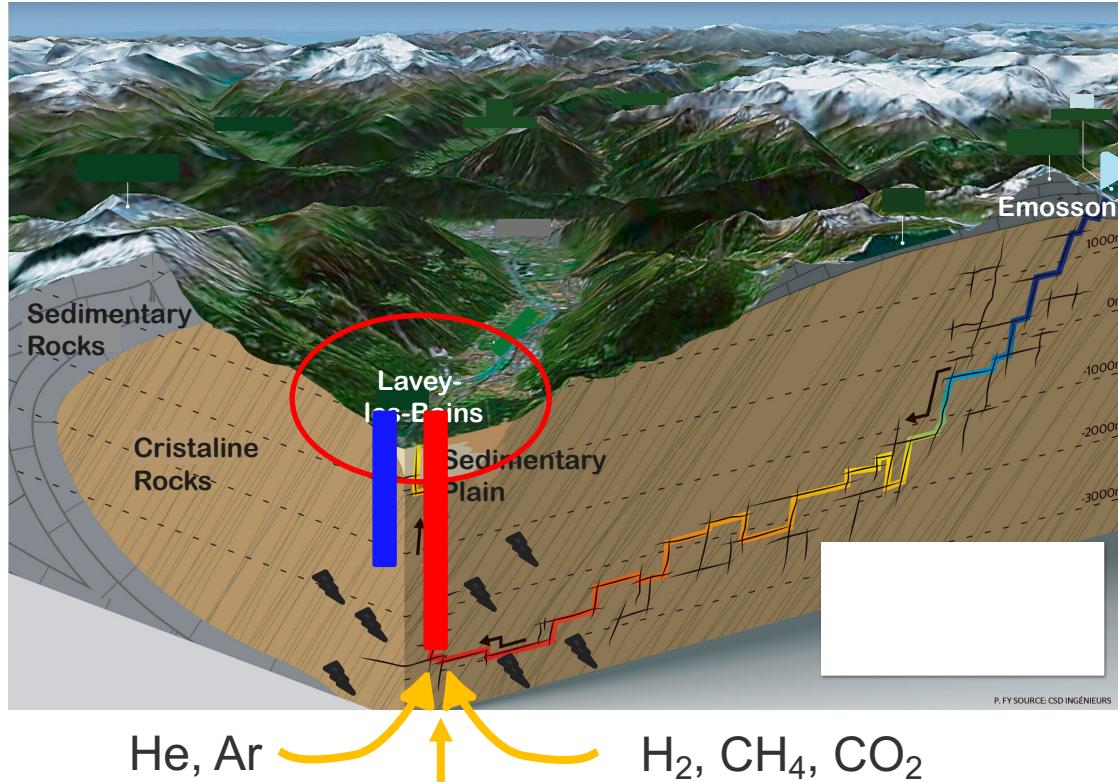


2. Lavey-les-Bains



2. Lavey-les-Bains

Is there a relation between seismicity and fluid dynamics ?



Ar, Kr, N₂, O₂

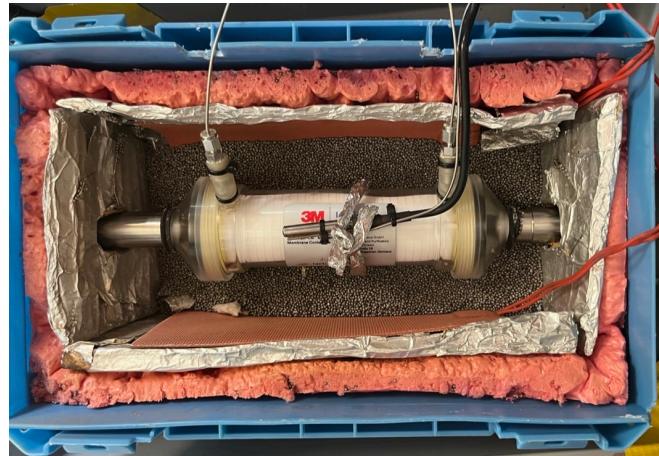
Wells:

- 200m bgl
- 500m bgl

2. Lavey-les-Bains

The miniRuedi

– He gets free hot water...

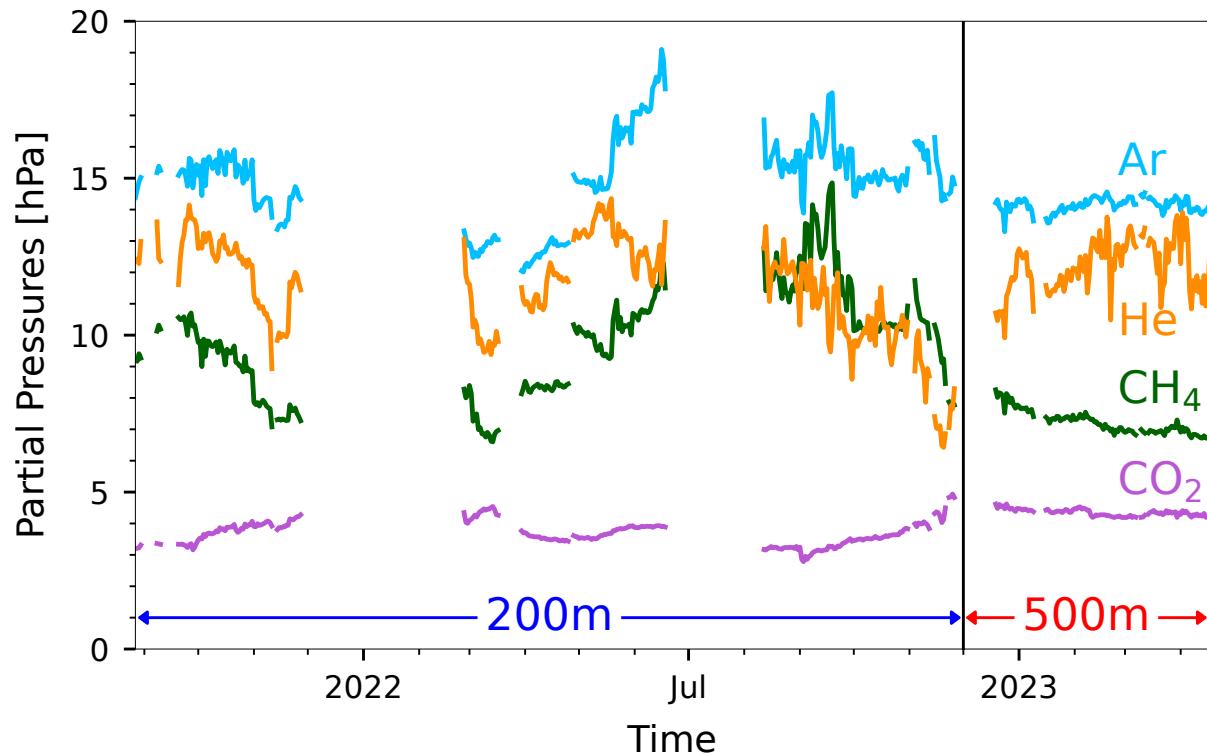


2. Lavey-les-Bains

Gas Measurements

In total:

- 8 gases
- 54k meas/gas

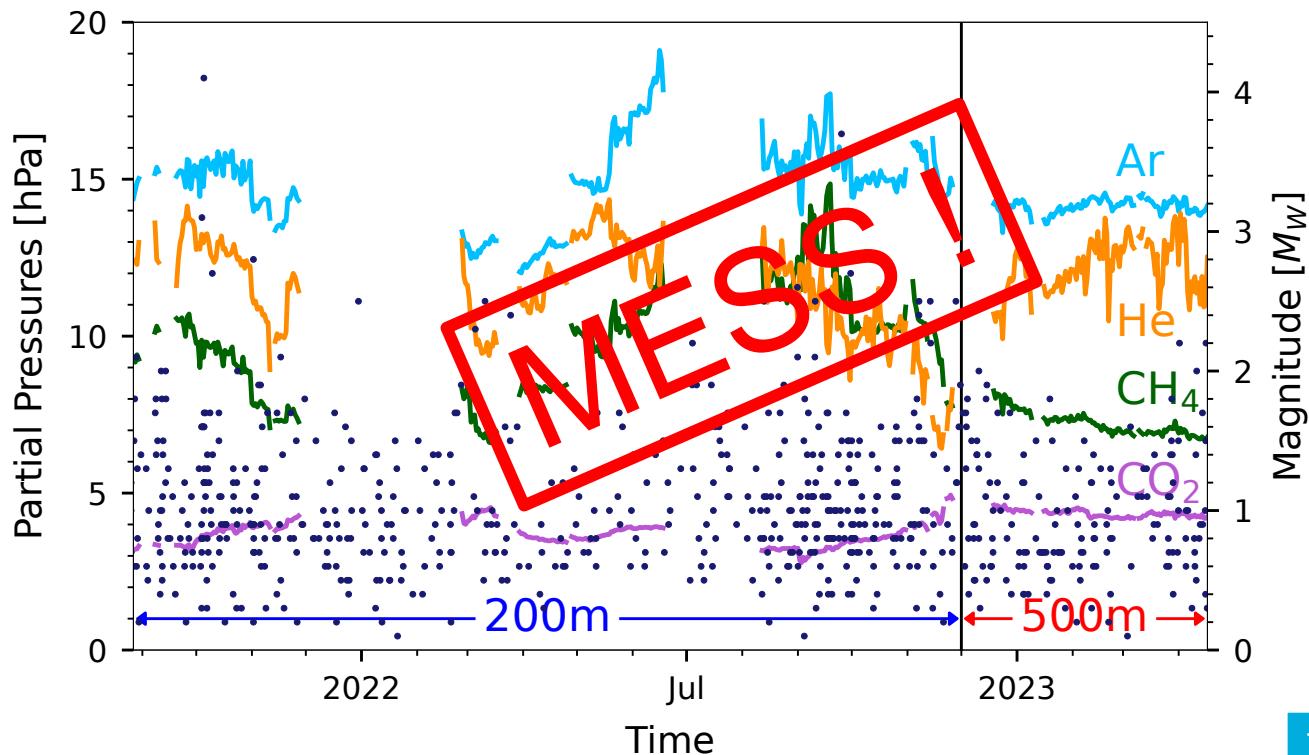


2. Lavey-les-Bains

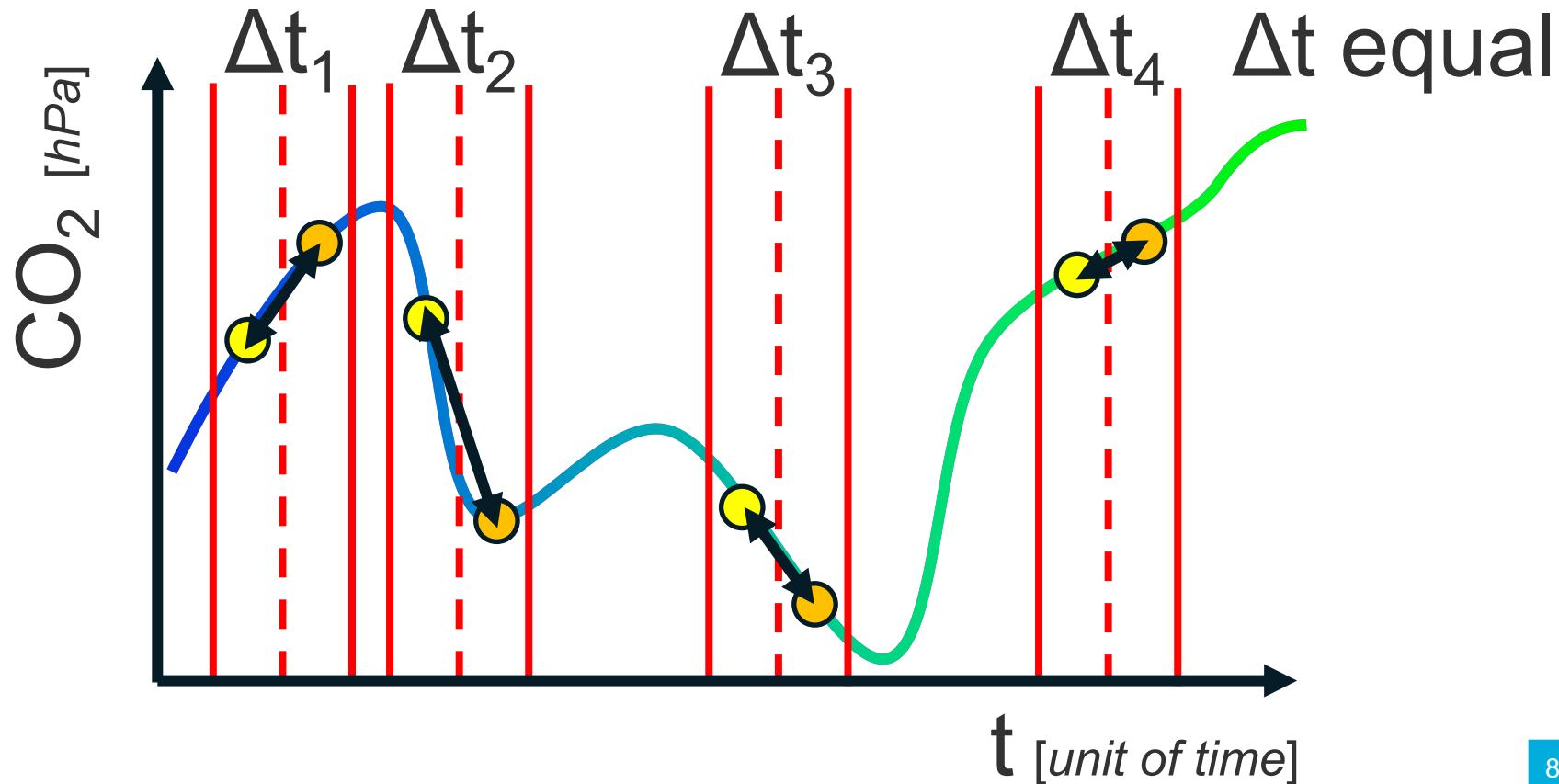
Gas Measurements

In total:

- 8 gases
- 54k meas/gas
- +1000 earthquakes



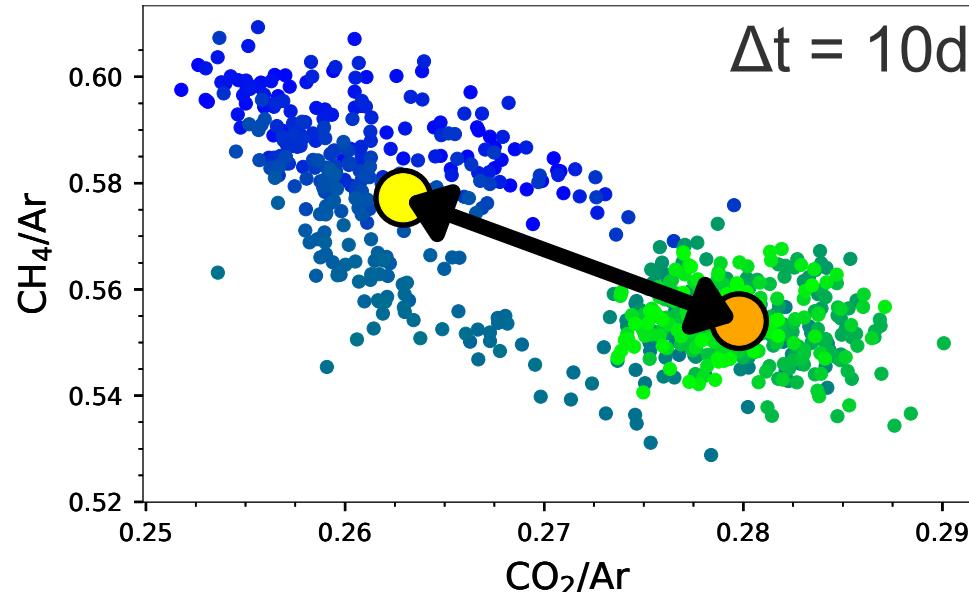
2. Lavey-les-Bains



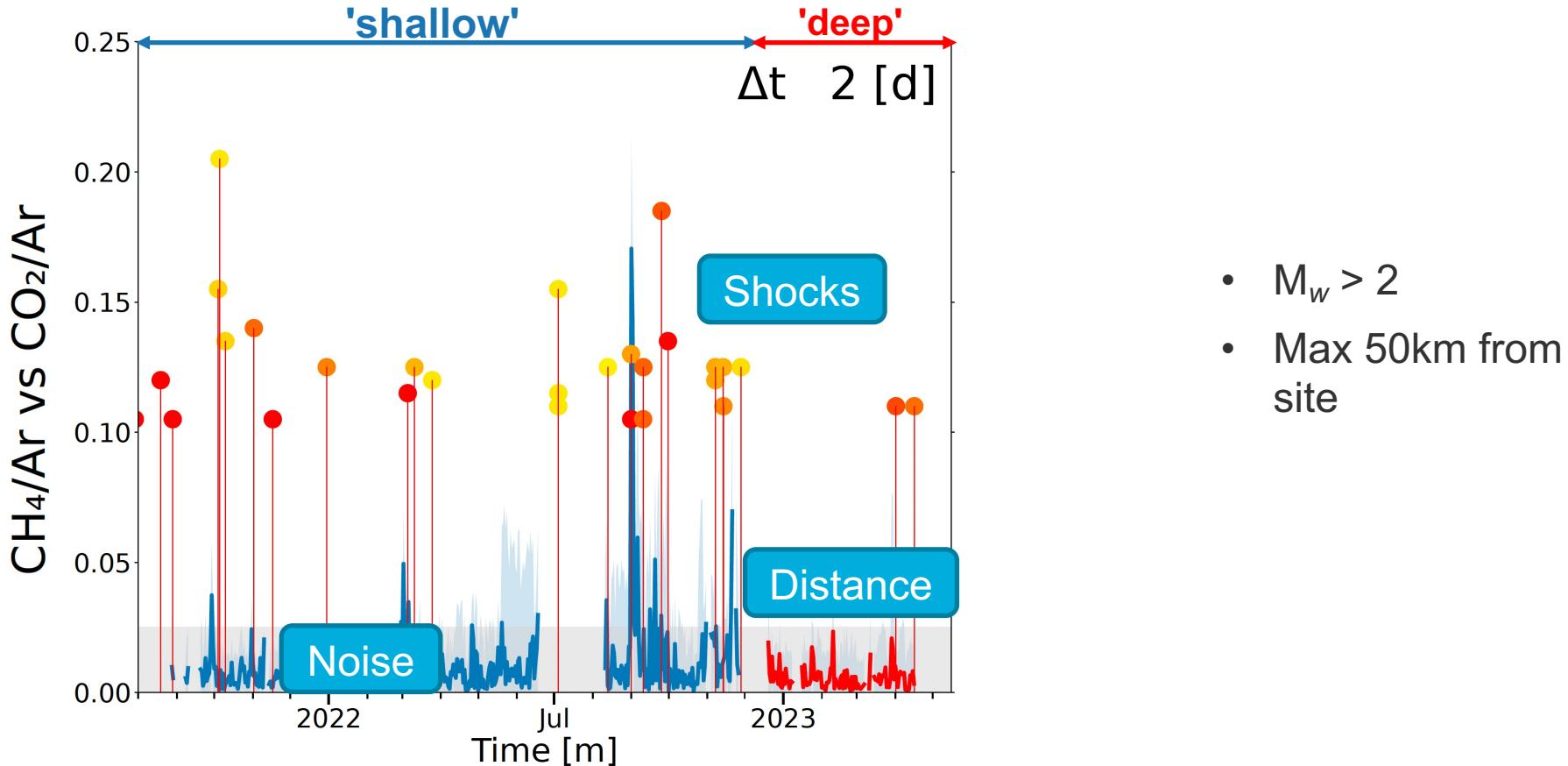
2. Lavey-les-Bains

How to apply that concept?

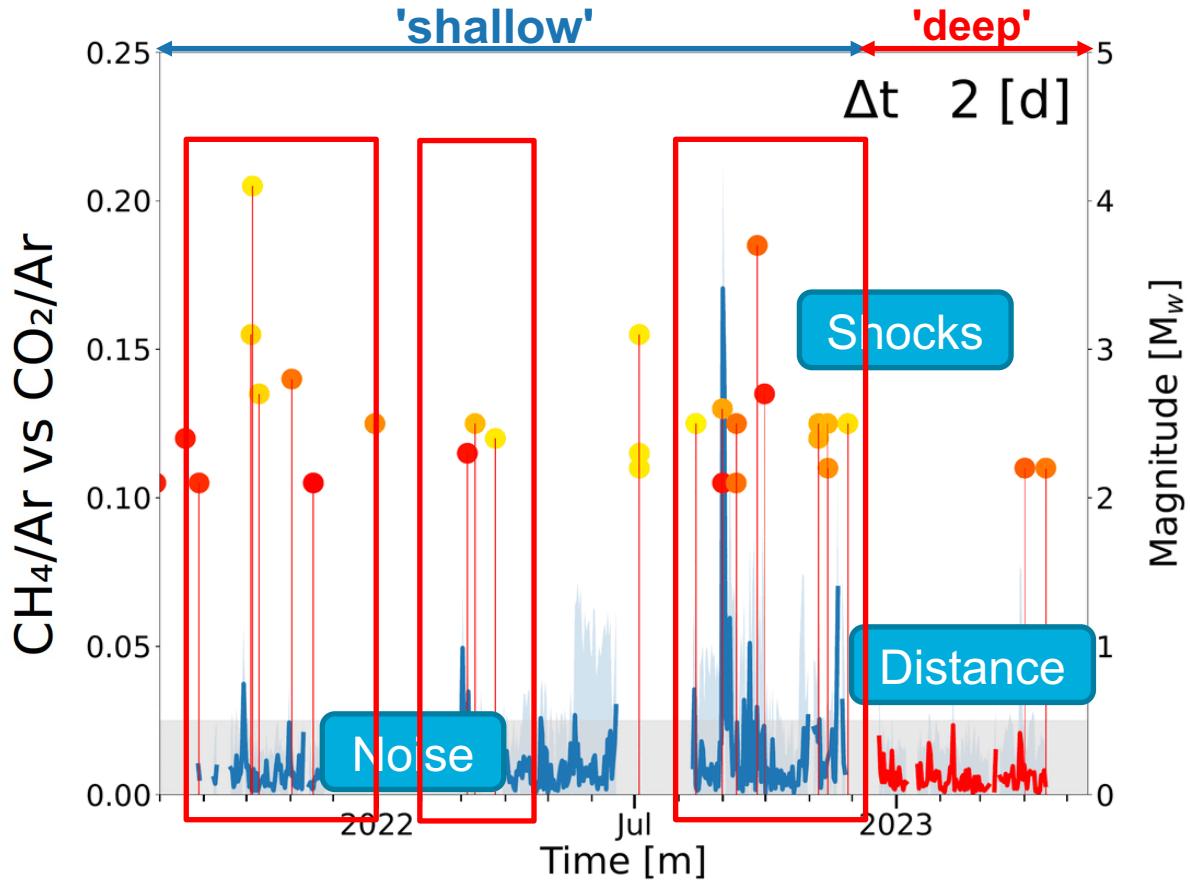
1. We chose $\text{dist} = \sqrt{\Delta(\text{CH}_4/\text{Ar})^2 + (\Delta\text{CO}_2/\text{Ar})^2}$



2. Lavey-les-Bains



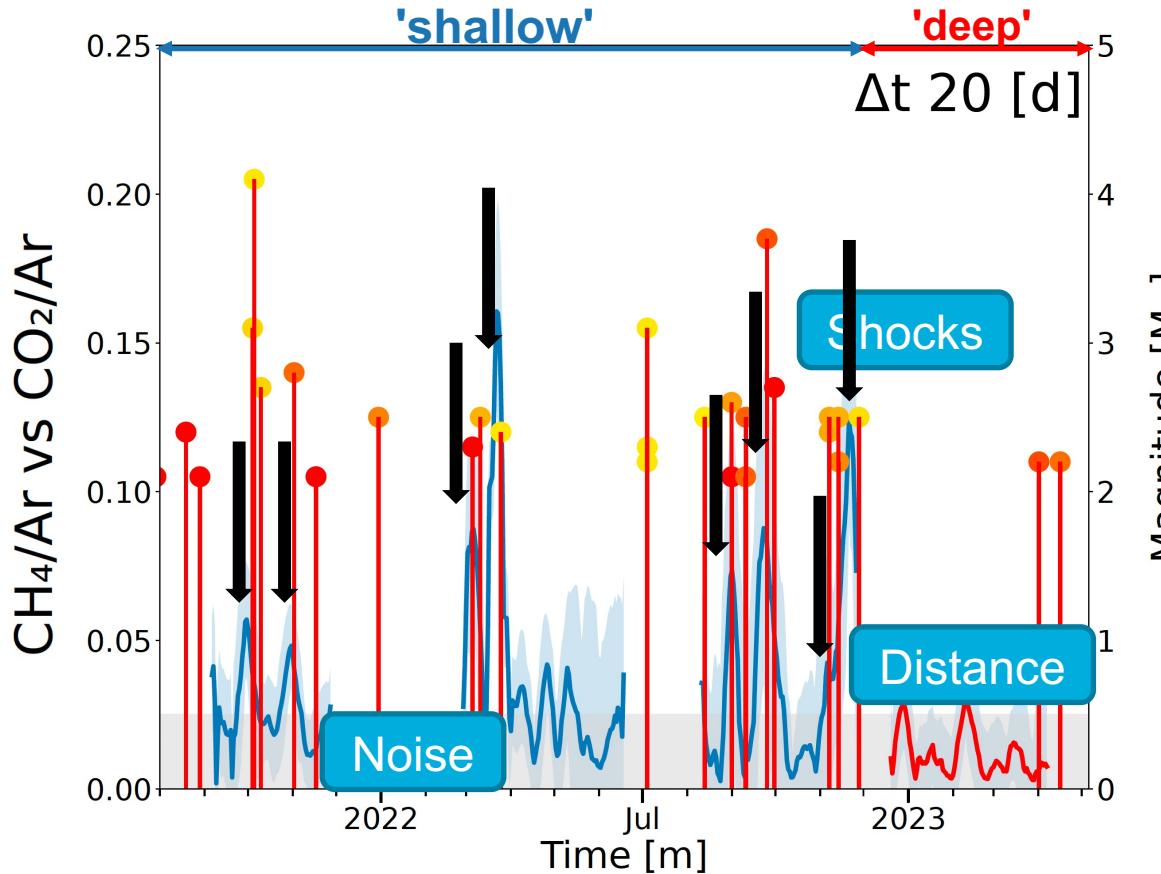
2. Lavey-les-Bains



Shallow well show
a response

Deep does not care

2. Lavey-les-Bains

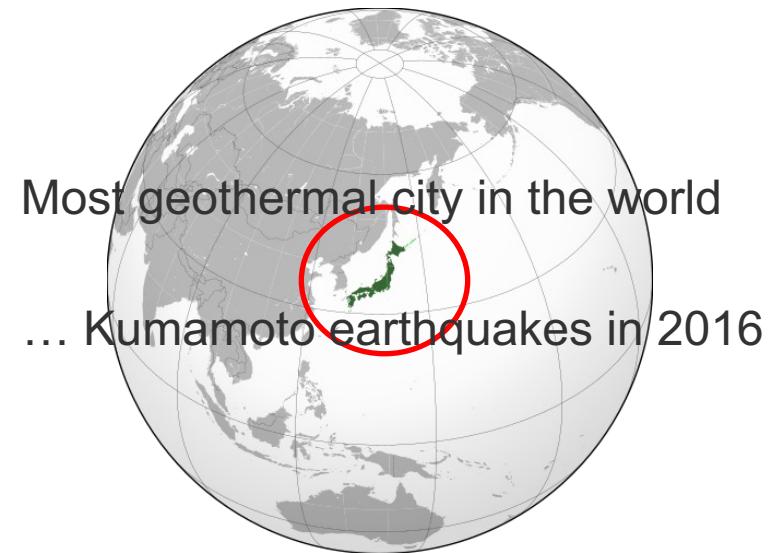


Shallow well show a response

Deep does not care

Signals seem to anticipate EQs

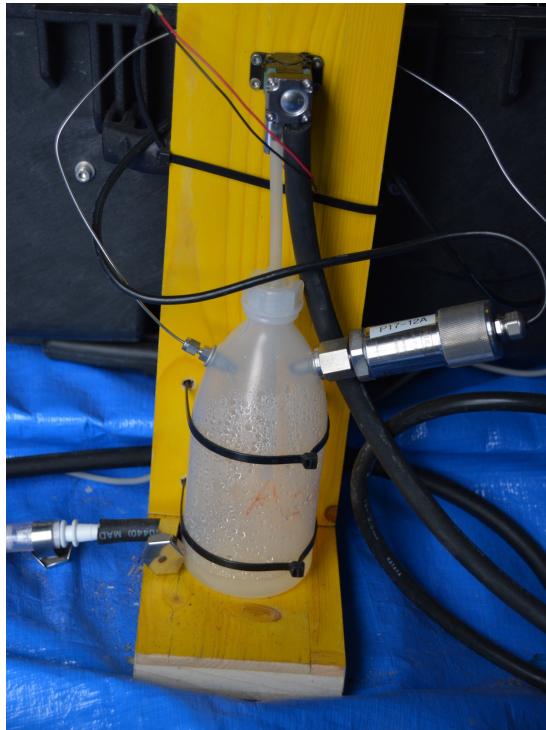
3. Beppu



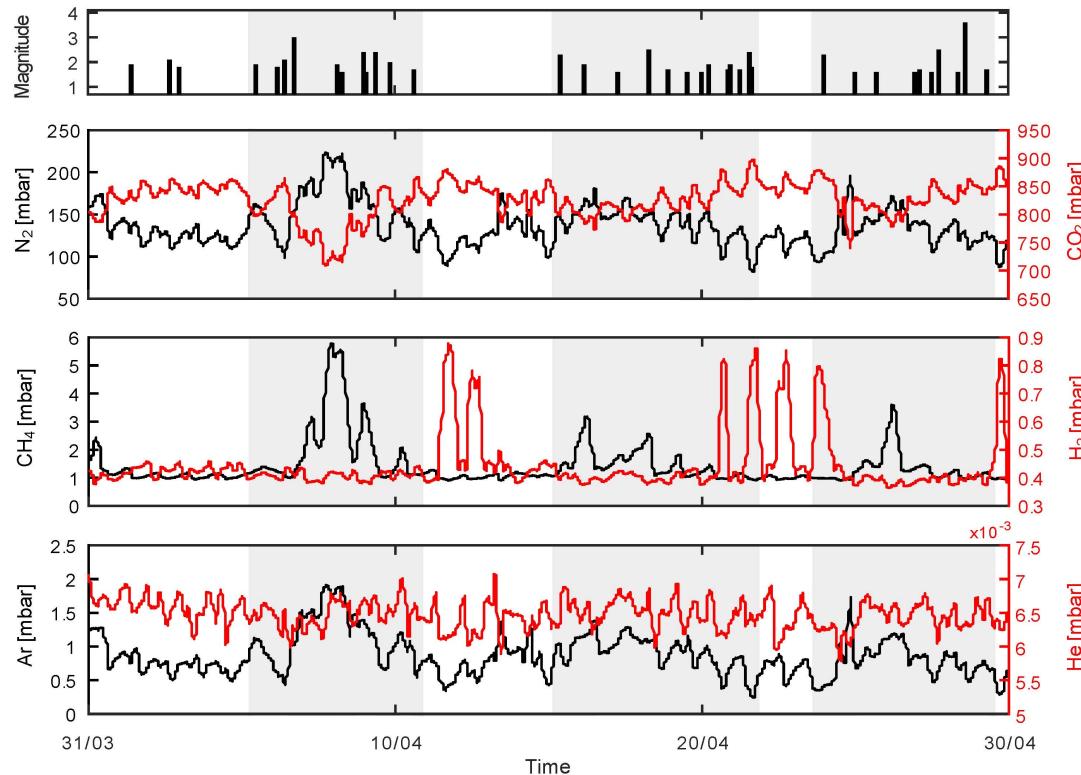
3. Beppu



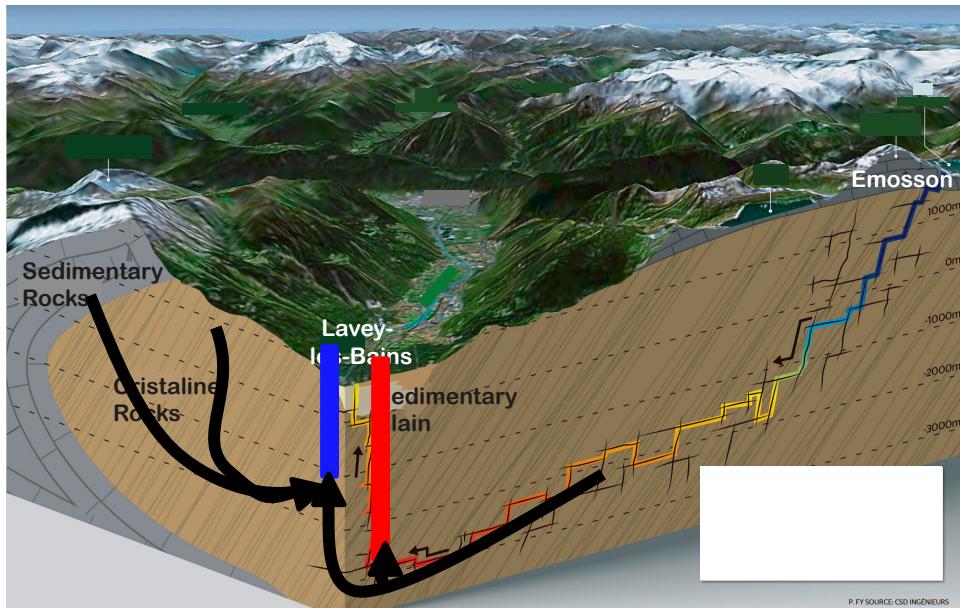
3. Beppu



3. Beppu



4. What is happening ?

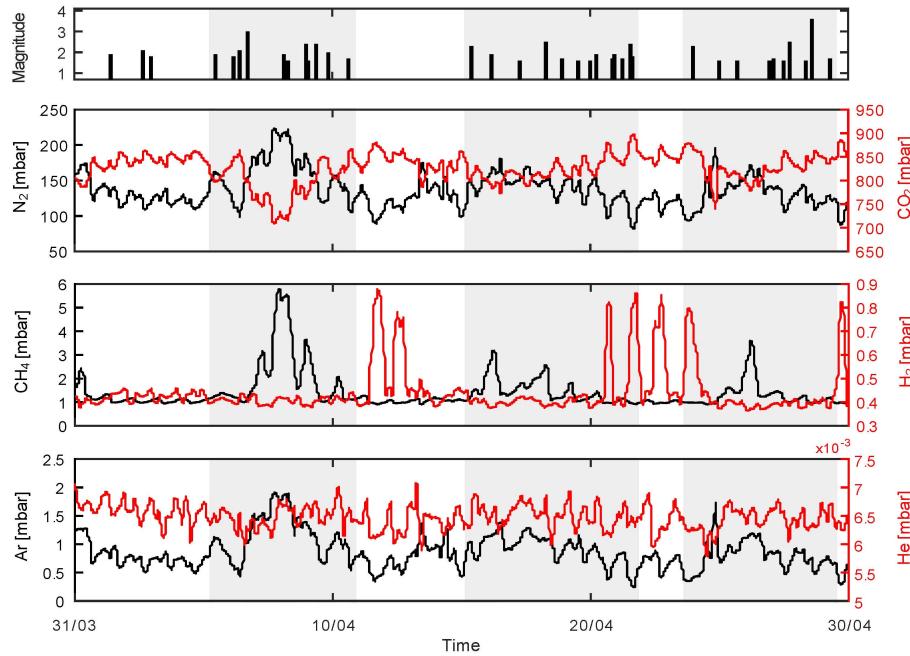


Perturbation through seismicity:

- Change of pore geometry
- Change of pore pressure

Change of mixing ratio in the well

4. What is happening ?



Perturbation through seismicity:

- Change of pore geometry
- Change of pore pressure

Change of mixing ratio in the well

Conclusion

Working at the spa does not provide free entrances, but...

Measured partial pressures of dissolved gases seem to correlate with seismic data.

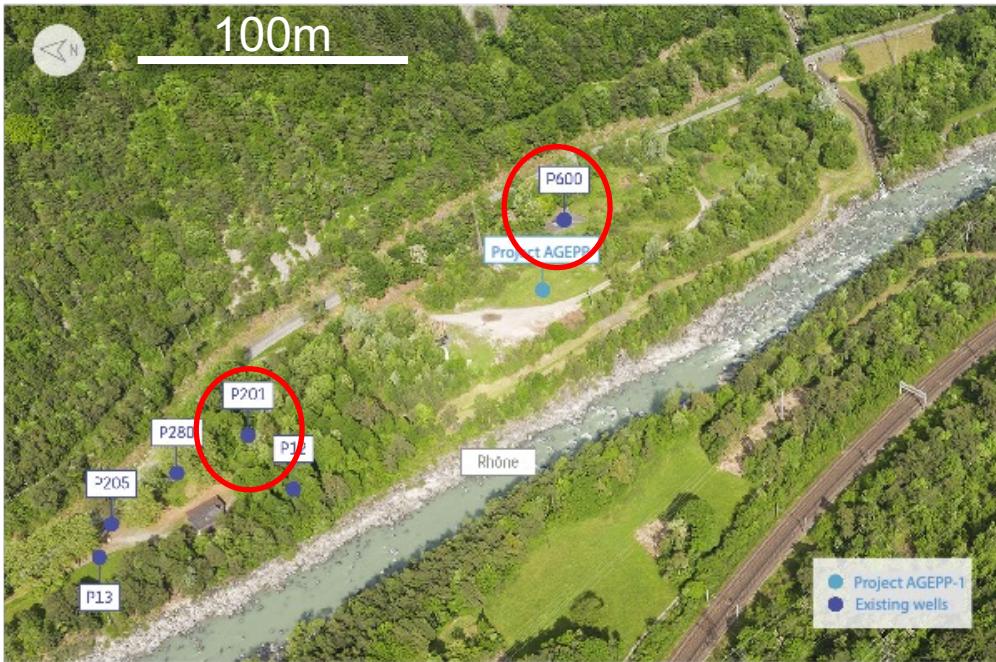
But only if you are not looking too deep !

Thank you

Questions ?

1. Site Description

Lavey-les-Bains

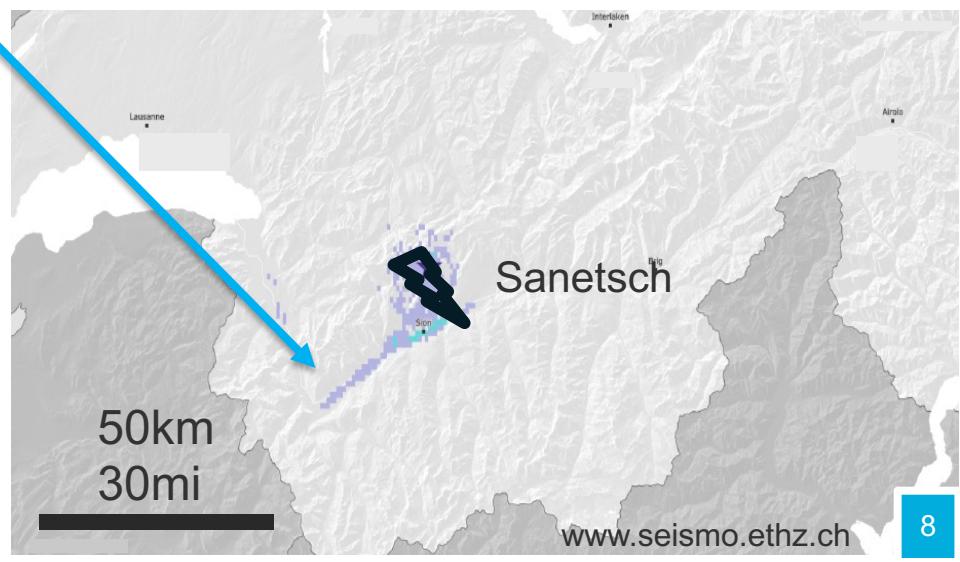
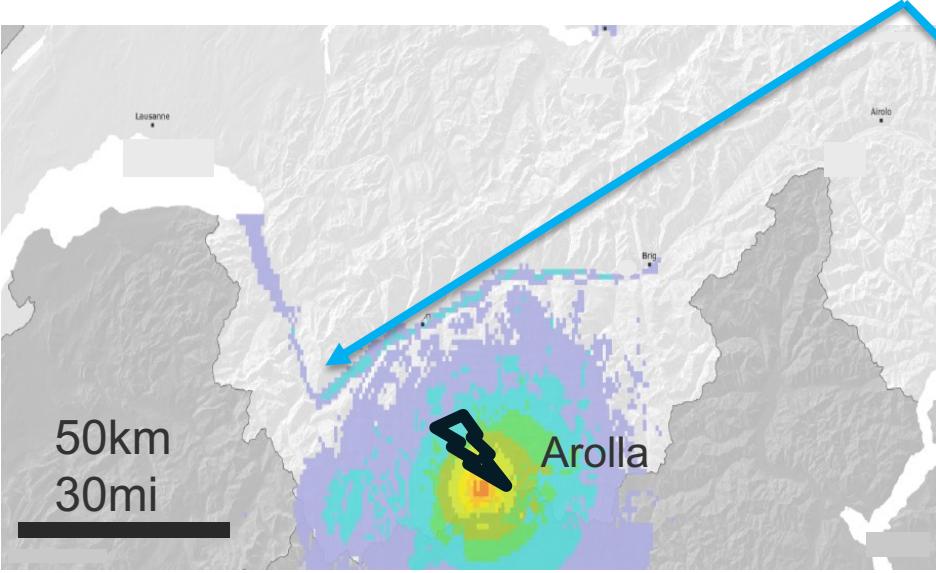


- Over 30 wells in the region
- P201 (200m bgl) and P600 (515m bgl): monitoring site
- Deep drilling: Lavey-1 (3000+m bgl)

2. Results

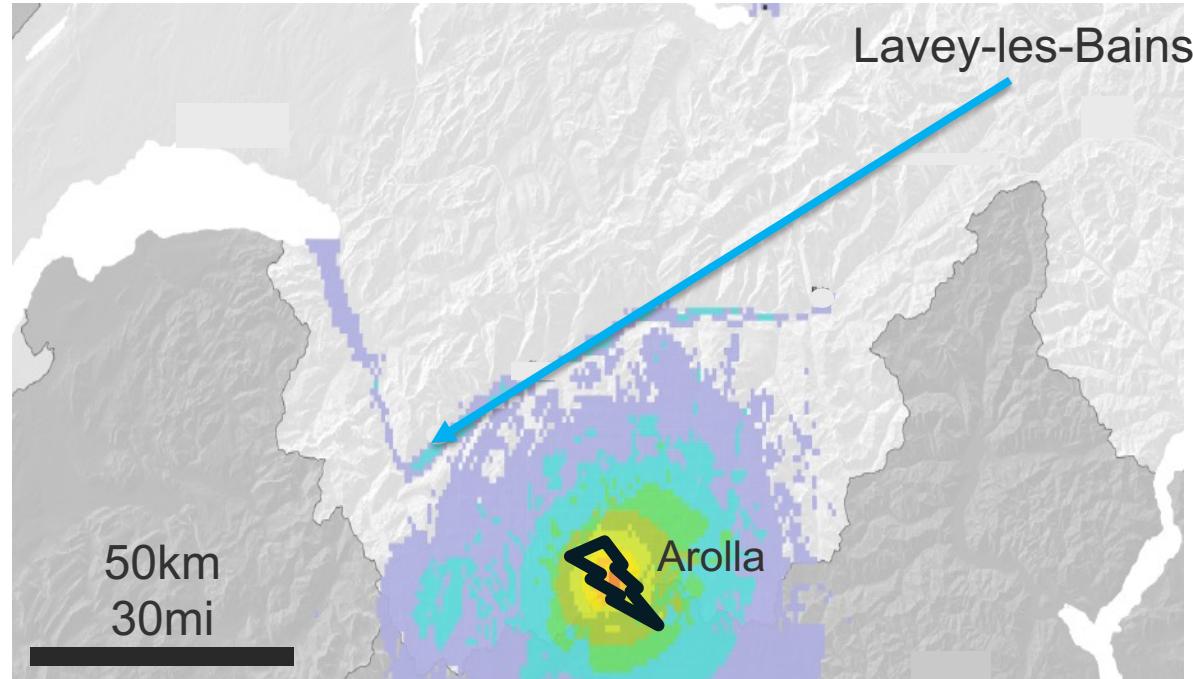
Earthquakes in October (Arolla, M=4.1) and November (Sanetsch, M=2.8)

Lavey-les-Bains



2. Results

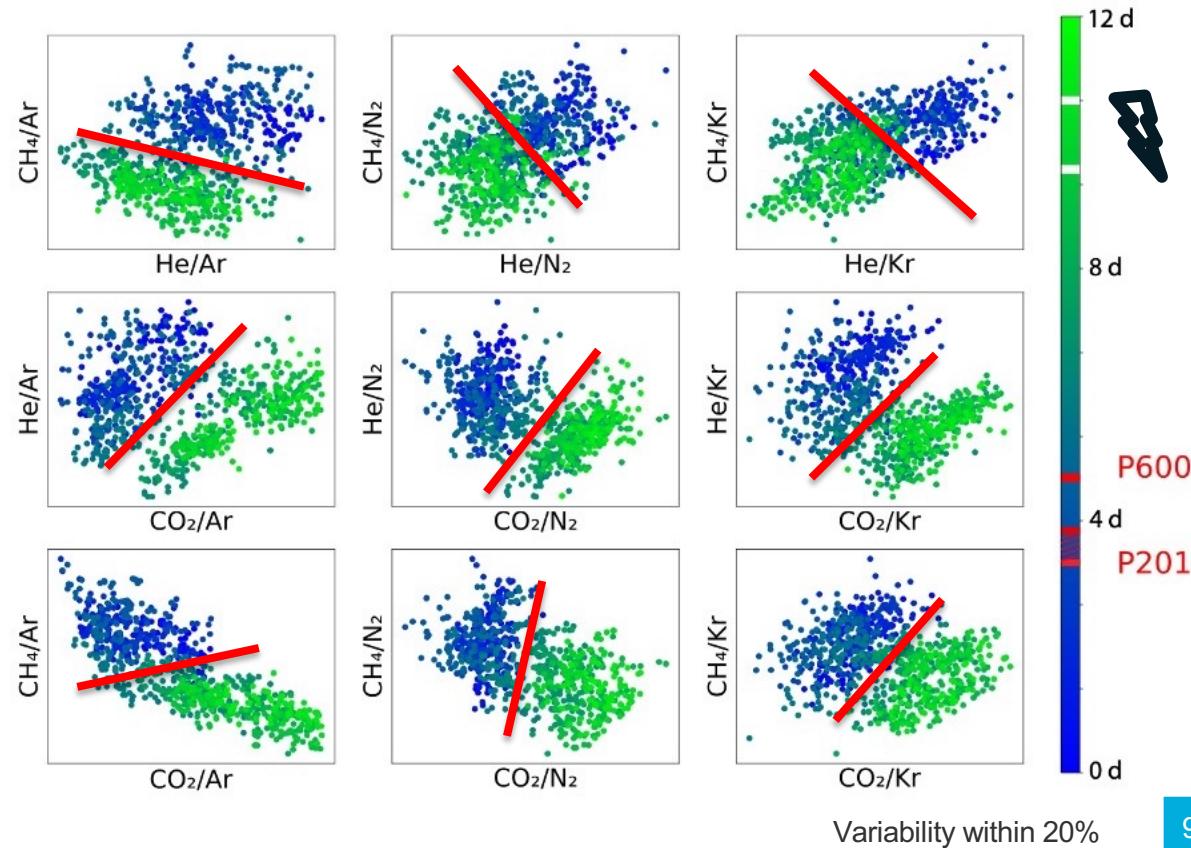
Earthquakes in October 2021 (Arolla, M=4.1)



2. Results

Arolla Earthquakes

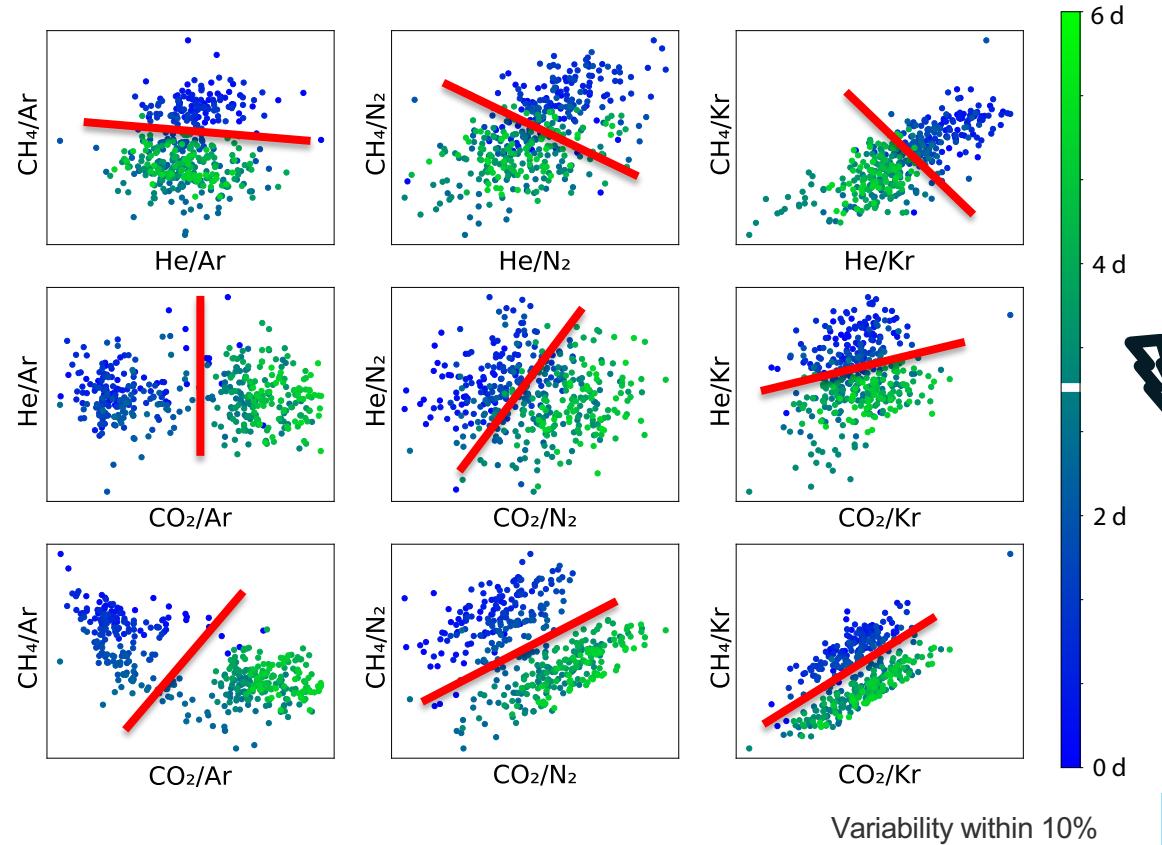
- Possible shift in gas ratios
- Why is there a shift ?



2. Results

Sanetsch Earthquake

- Similar shift observed in another seismic event



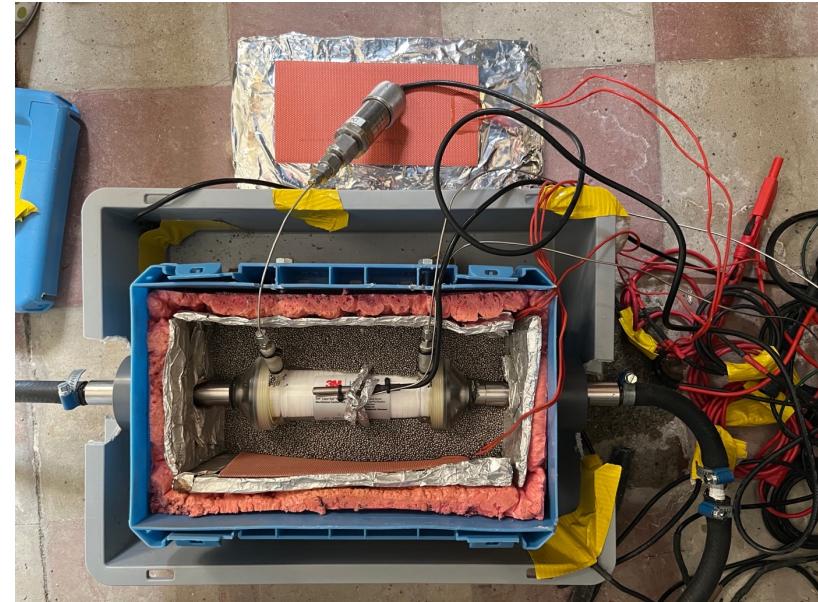
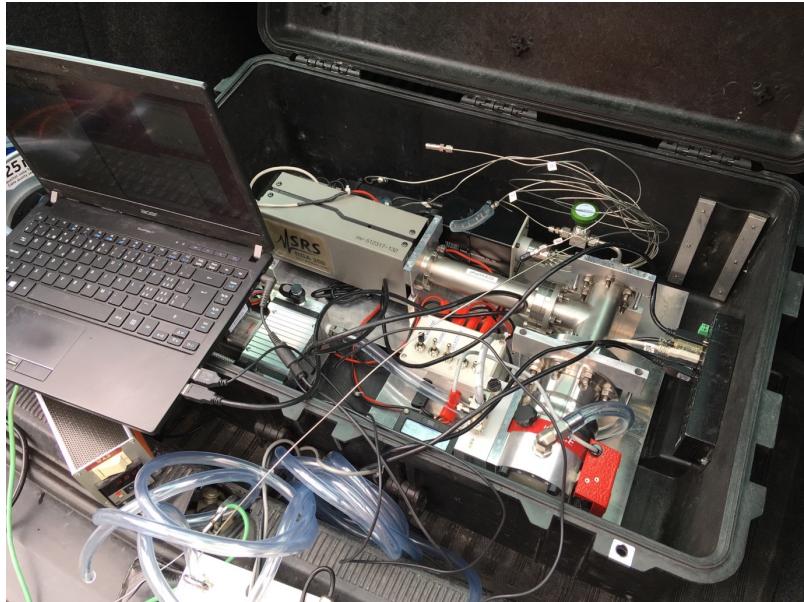
Setup for the On-site Noble Gas Monitoring

Use of Noble Gases

- Access to deep thermal water (200mbgs – 550mbgs)
- Tracking of dissolved noble gases and other gases:
 - He, Ar and Kr
 - CH₄, N₂, H₂, O₂ and CO₂
- Use of different tools: noble gas mass spectrometry and miniRUEDI

2. Method

Adaptation of the miniRuedi Lavey-les-Bains



Gas Monitoring

Setup for the On-site Noble Gas Monitoring

The different tools

Noble gas mass spectrometry



MiniRuedi

