

General Assembly 17 – 09 – 2026 Woerden

Loes Buijze, Elisa Calignano, Wen Zhou, Boris Boullenger, Stefan Peeters,
Lies Peters, Slawek Szklarz, Hans Veldkamp (TNO)
Eelco Veen (Ennatuurlijk Aardwarmte), Jurriaan Reijs (GAIA Energy)
Deyan Draganov, David Naranjo (TU Delft)

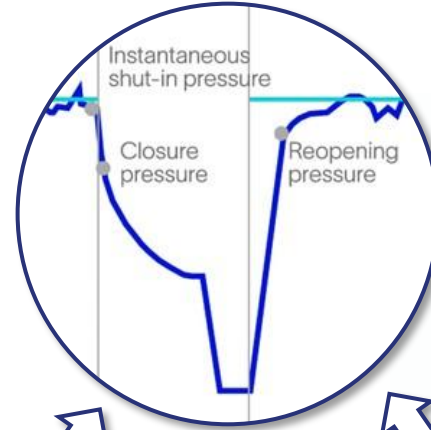
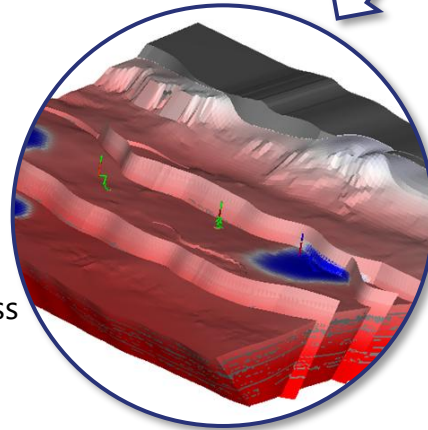
WP4

Where is cooling in the subsurface?
And does it cause seismicity or
caprock fracturing?

Big 3Ms!

Modeling

3D models, cooling, stress



Measuring

In-situ stress, permeability, velocity, **temperature**

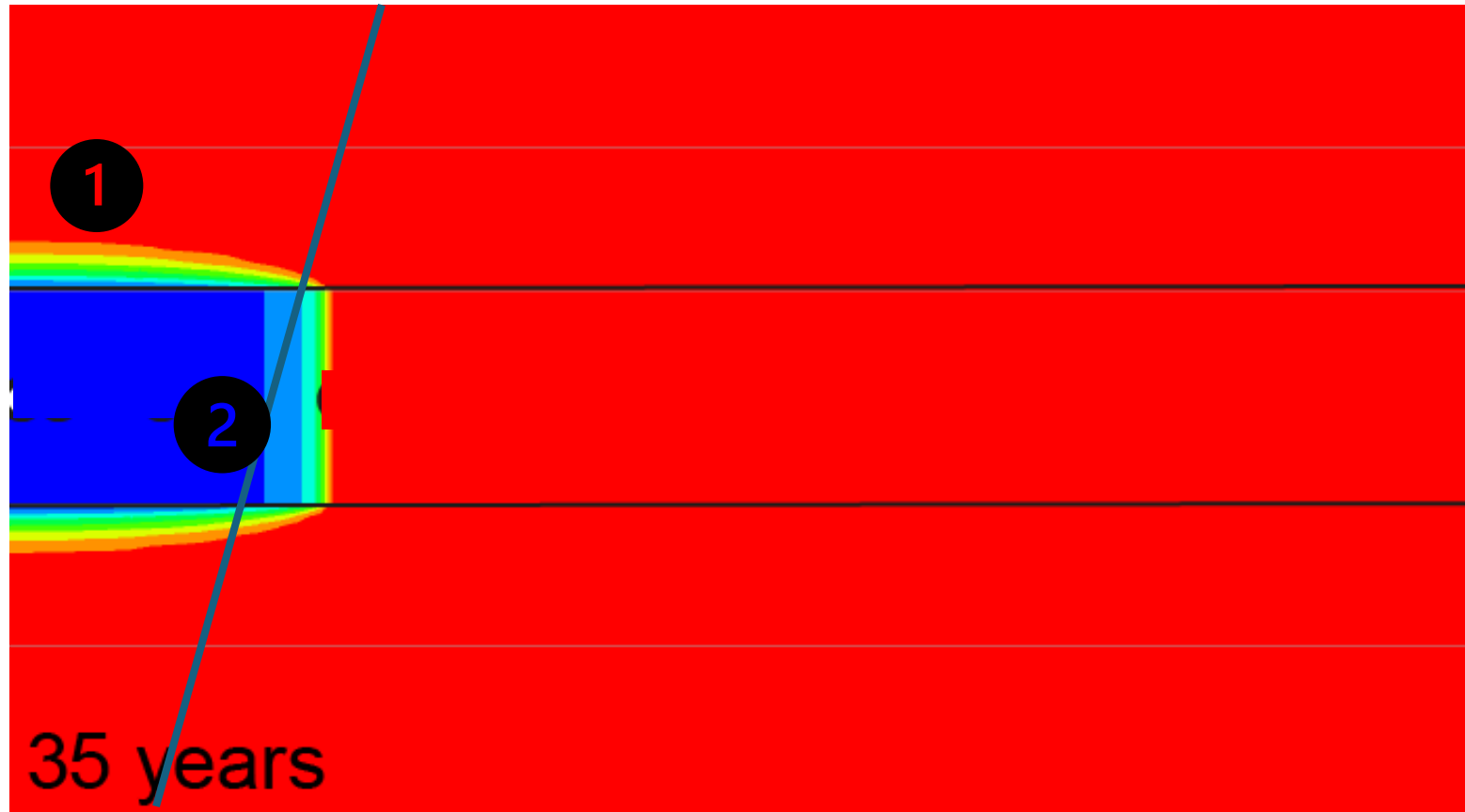


Monitoring

Deep geophones, surface networks, DAS

**Evidence for lower injection temperatures and higher injection pressure
within a safe and optimal production framework**

Cooling: why do we care?



- 1) Caprock integrity
- 2) Fault reactivation
- 3) Doublet lifetime
- 4) License boundary

Affects your production limits (TAS, SHRA)

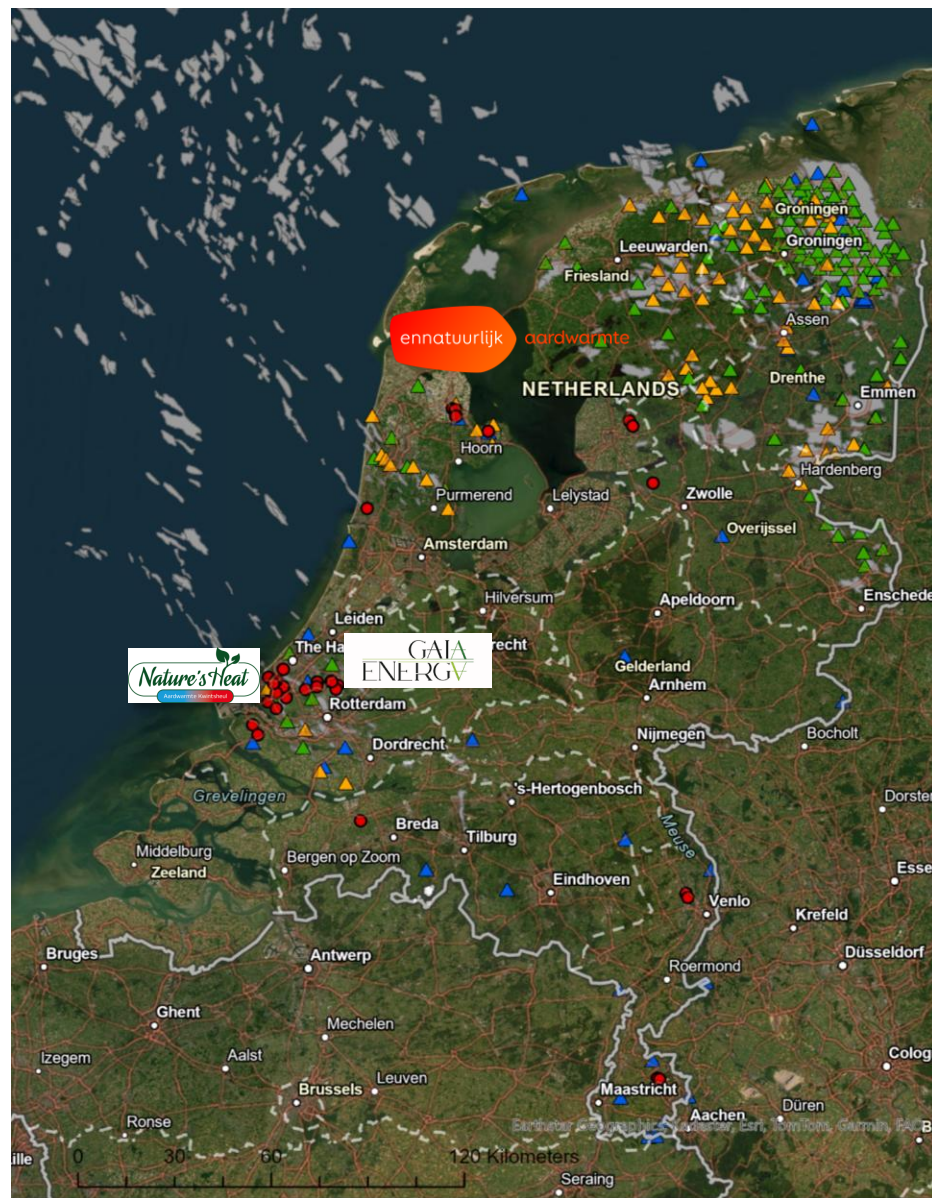
Field data lacking



SRIMA TAS & SHRA

Kwintsheul

Surface network, active survey, modeling



Middenmeer

mini-frac test and well logs
Deep toolstring → Surface station



Bleiswijk

700 m deep toolstring →
1.8 km deep geophones + DTS,
XLOT, Temperature Logs
surface network, modeling

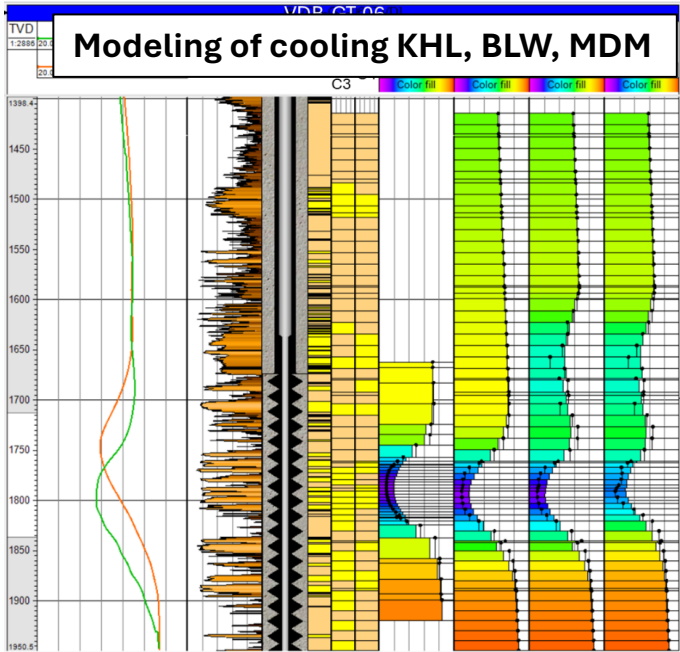
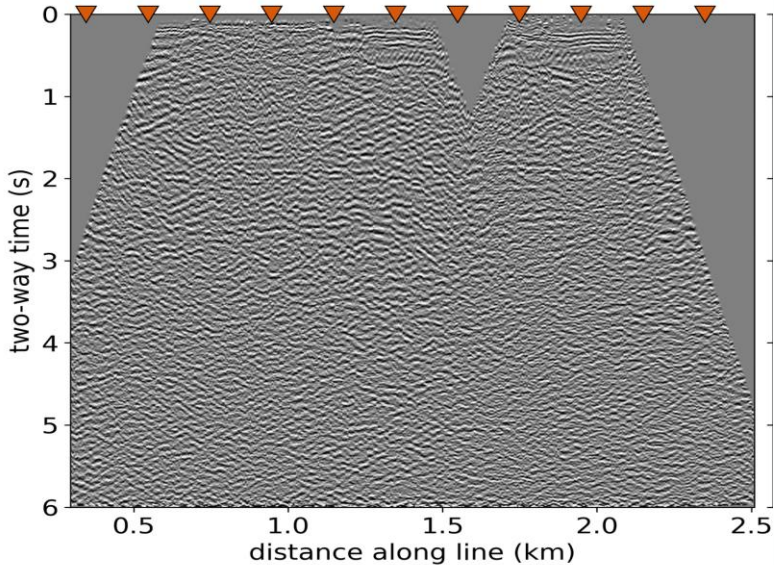


Summary main activities

Installation of surface & 200 m stations



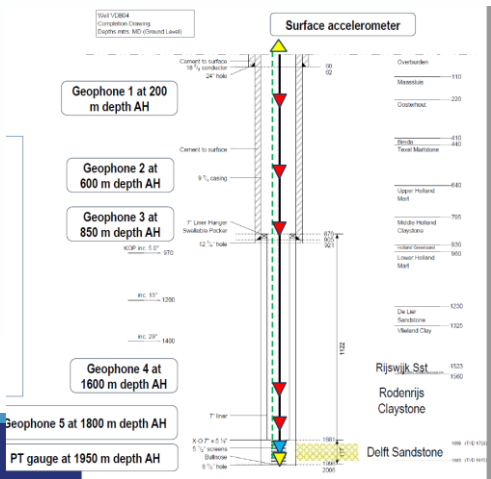
Velocity model Kwintsheul



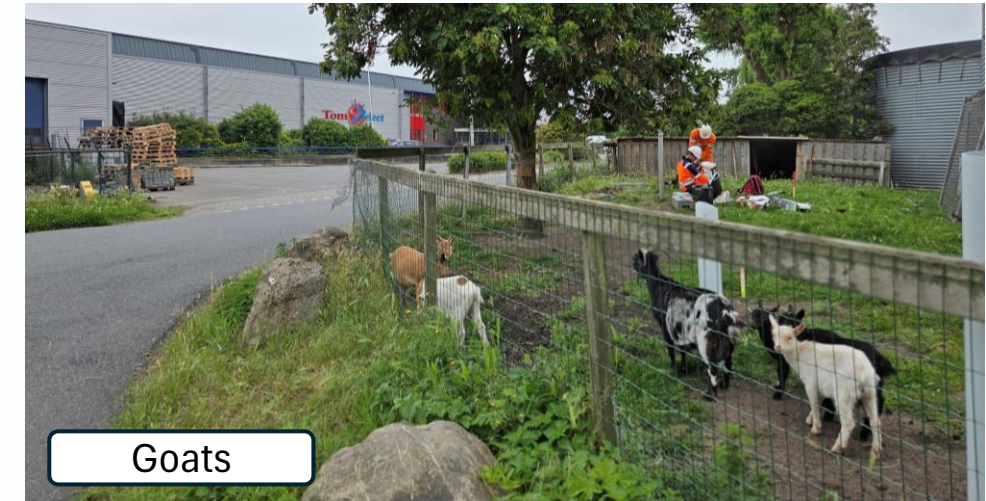
Progress Meetings WP4



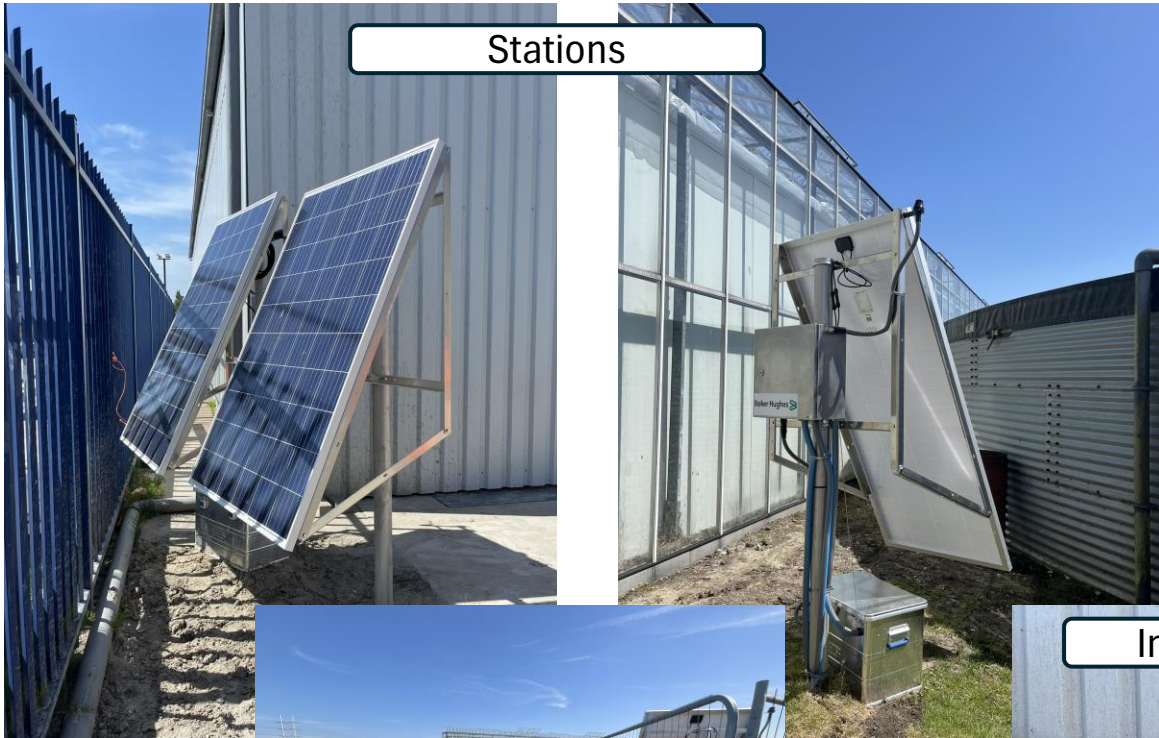
(re)Planning station deployments and stress tests



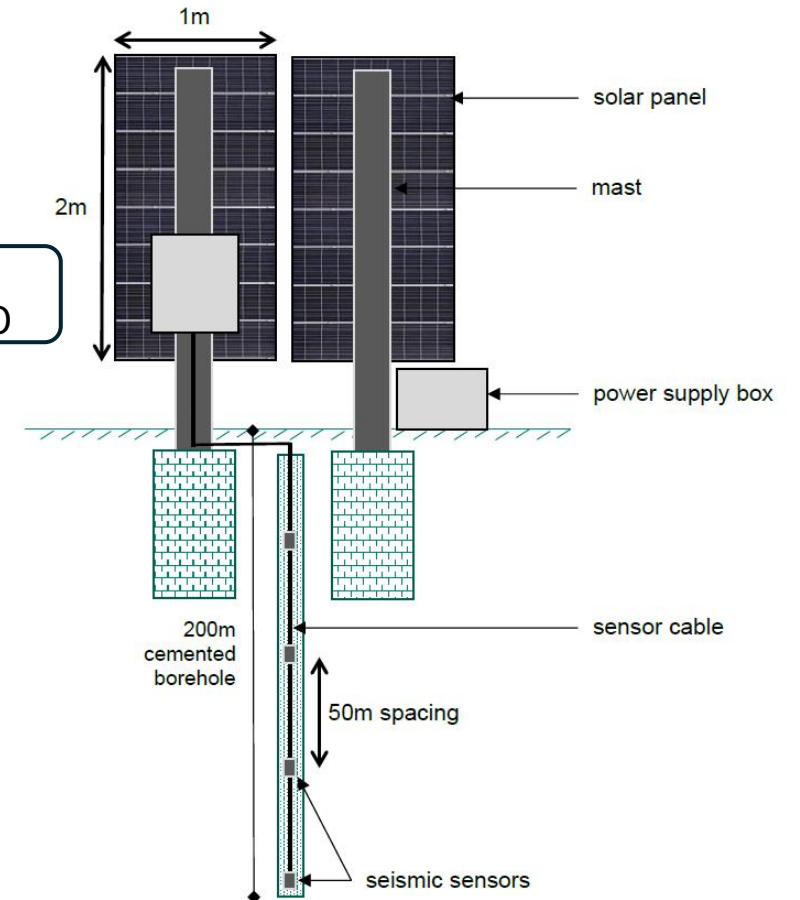
Highlight: Station deployments June 2026



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Data logger with connection to TNO



Inspection crew



Baker Hughes

Installation report
Geo4All

Kwintsheul and Bleiswijk, Netherlands

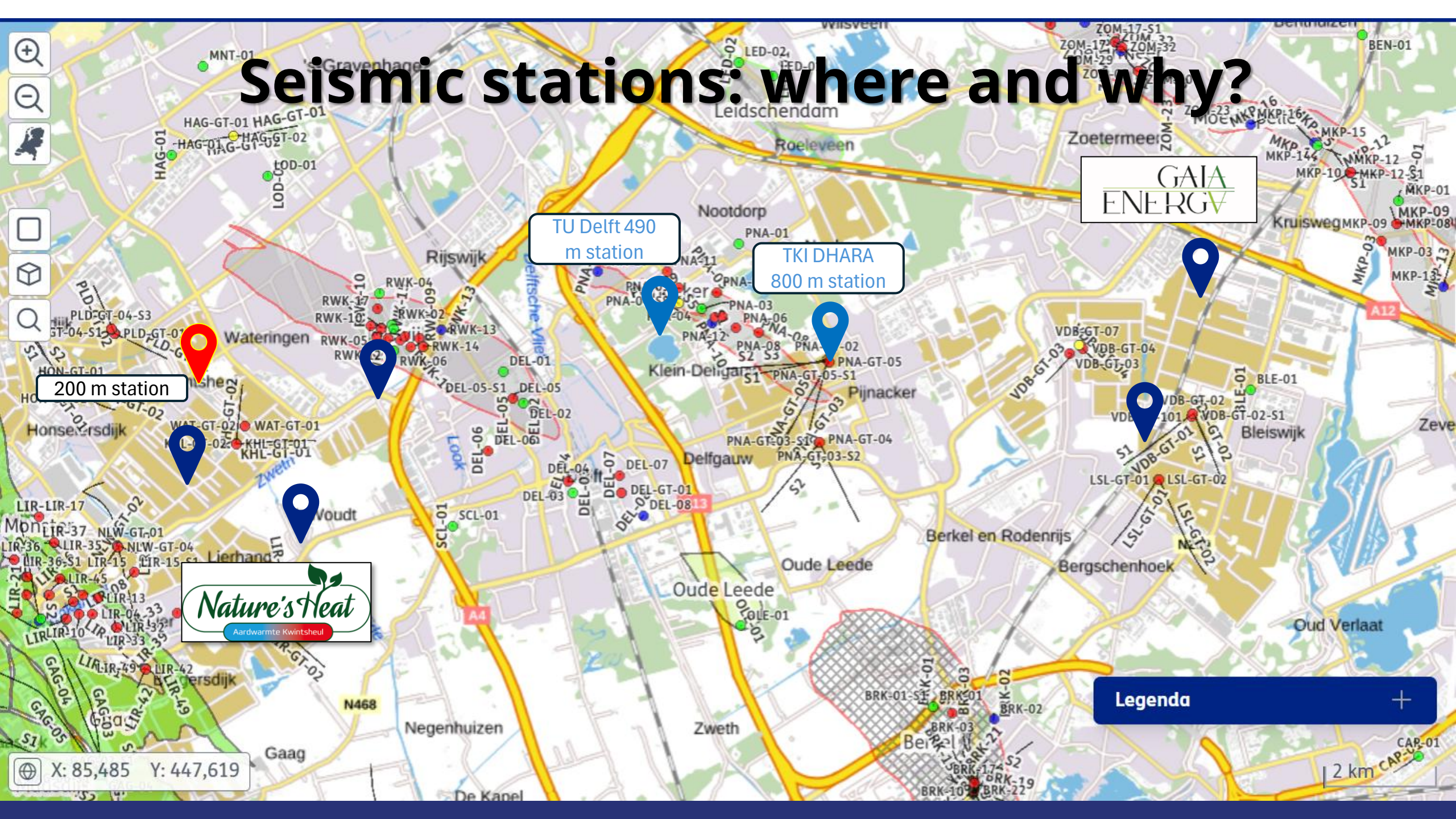
A report for the attention of

TNO

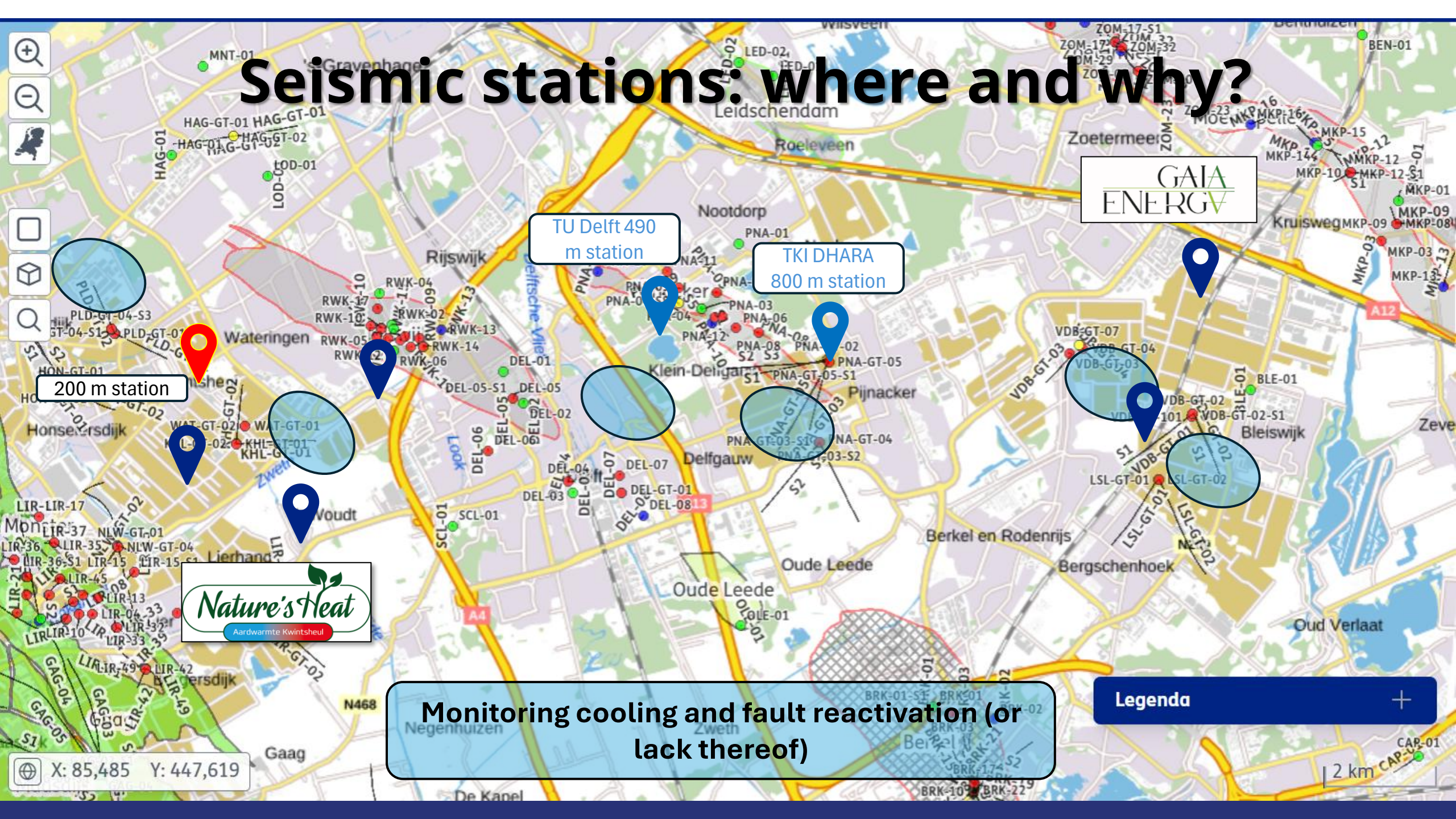
Mede mogelijk gemaakt door:

TKI NIEUW GAS
Topsector Energie

Seismic stations: where and why?



Seismic stations: where and why?



GAIA
ENERGY

TU Delft 490
m station

TKI DHARA
800 m station

200 m station

Nature's Heat
Aardwarmte Kwintsheul

Monitoring cooling and fault reactivation (or
lack thereof)

Legenda +

X: 85,485 Y: 447,619

2 km

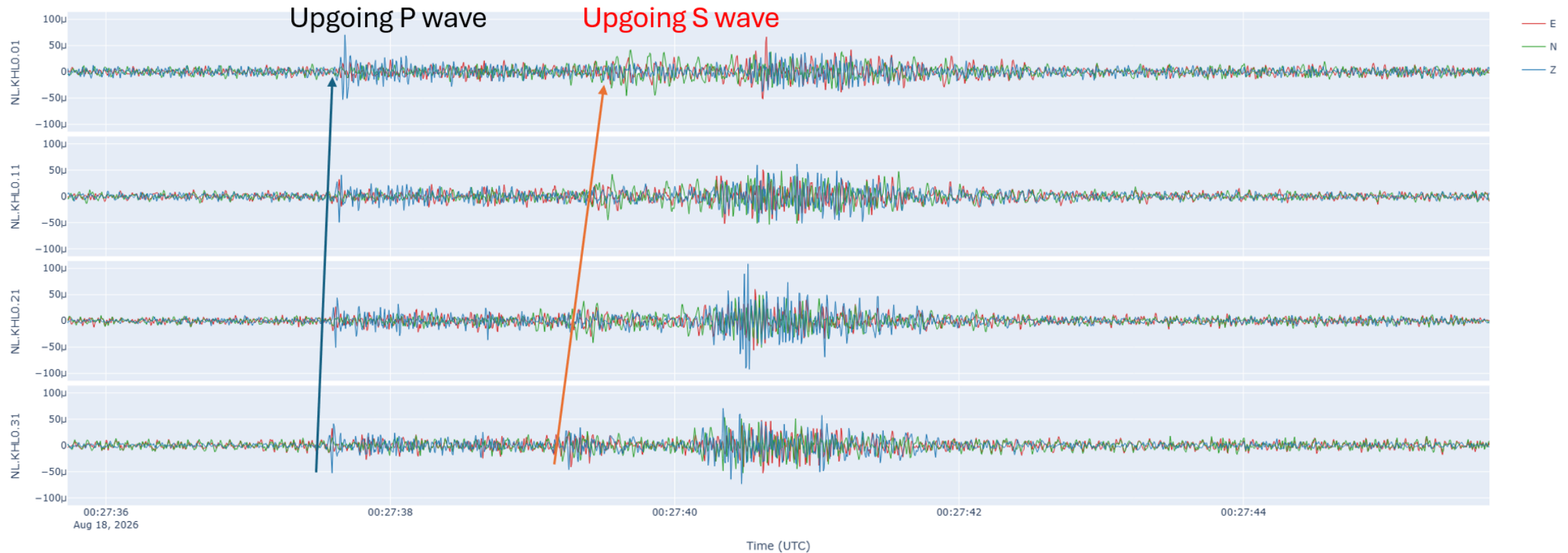
Lessons learnt

- Procurement is not easy
- Negotiating terms & conditions takes time
- Site visits and good alignment between all involved parties is important and also takes time
- Paul is good at finding supportive land owners
- Important to make KLIK melding
- .. de aanhouder wint

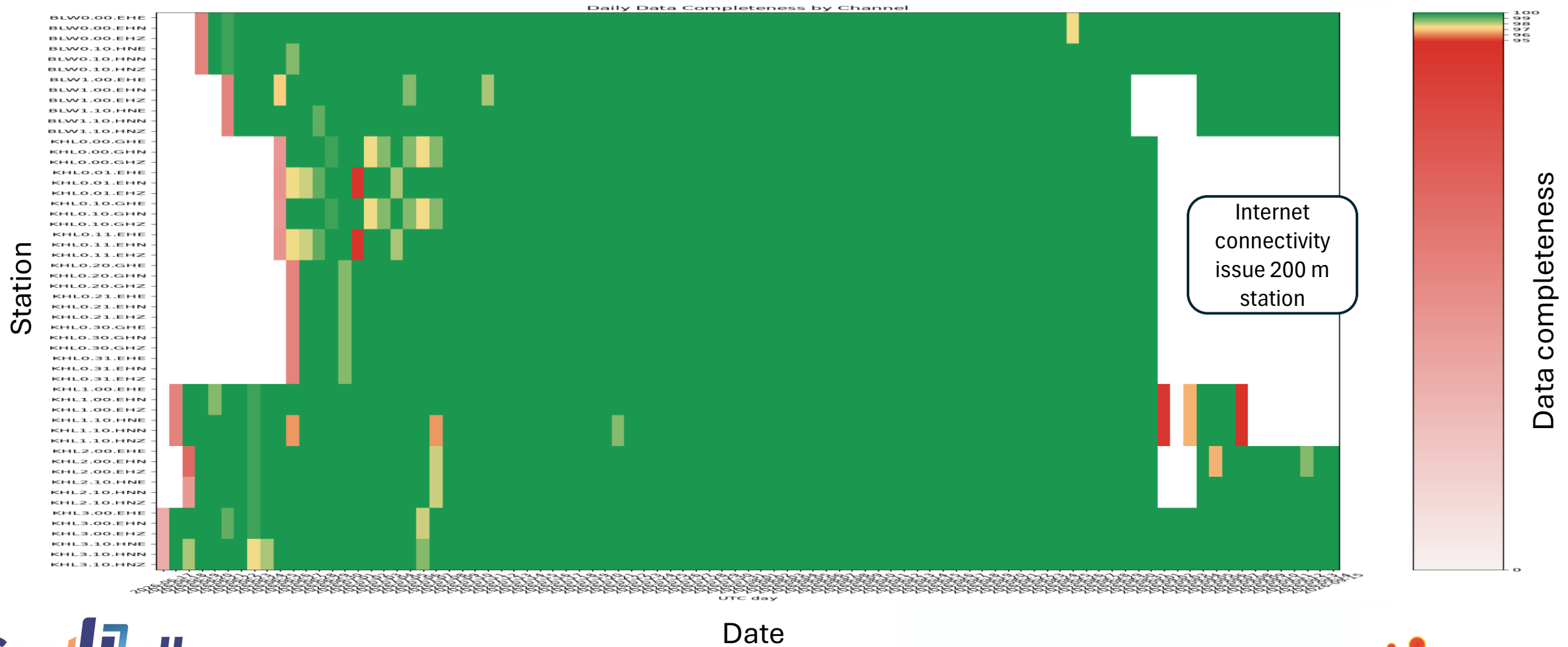


First insights – perforations Wippolder

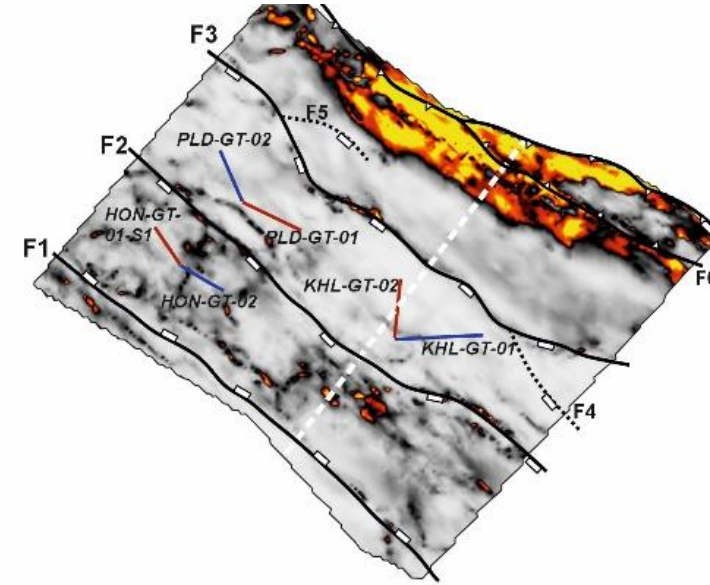
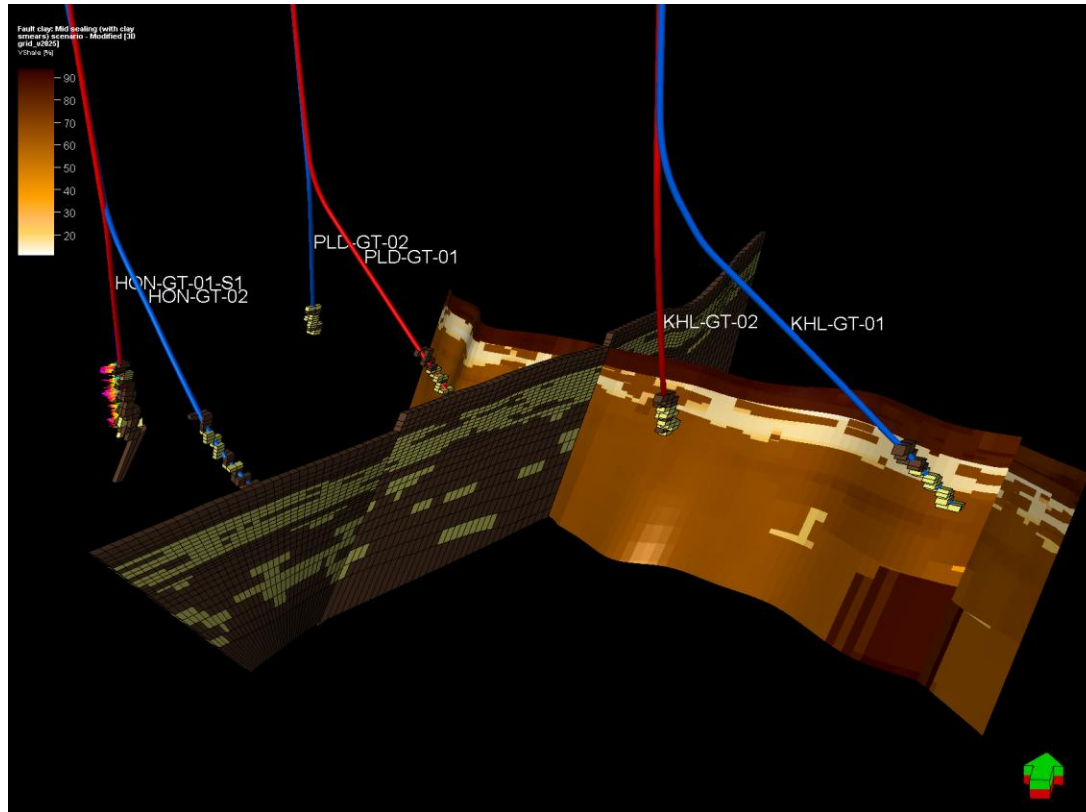
Kwintsheul perforation signal recorded by KHL0 geophones



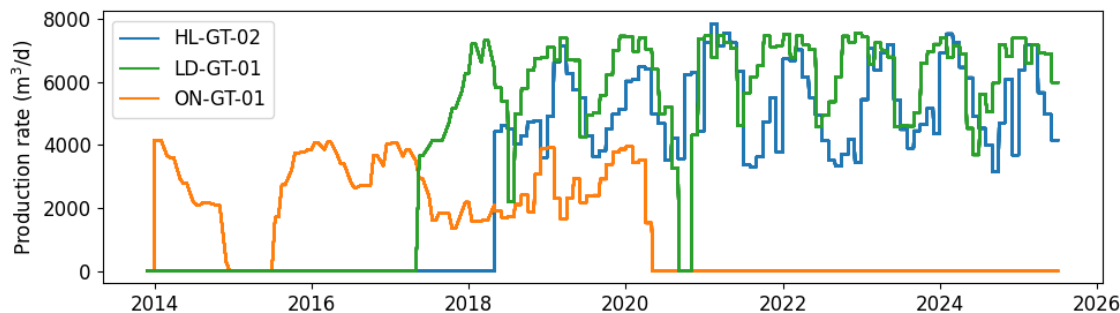
First insights – station health



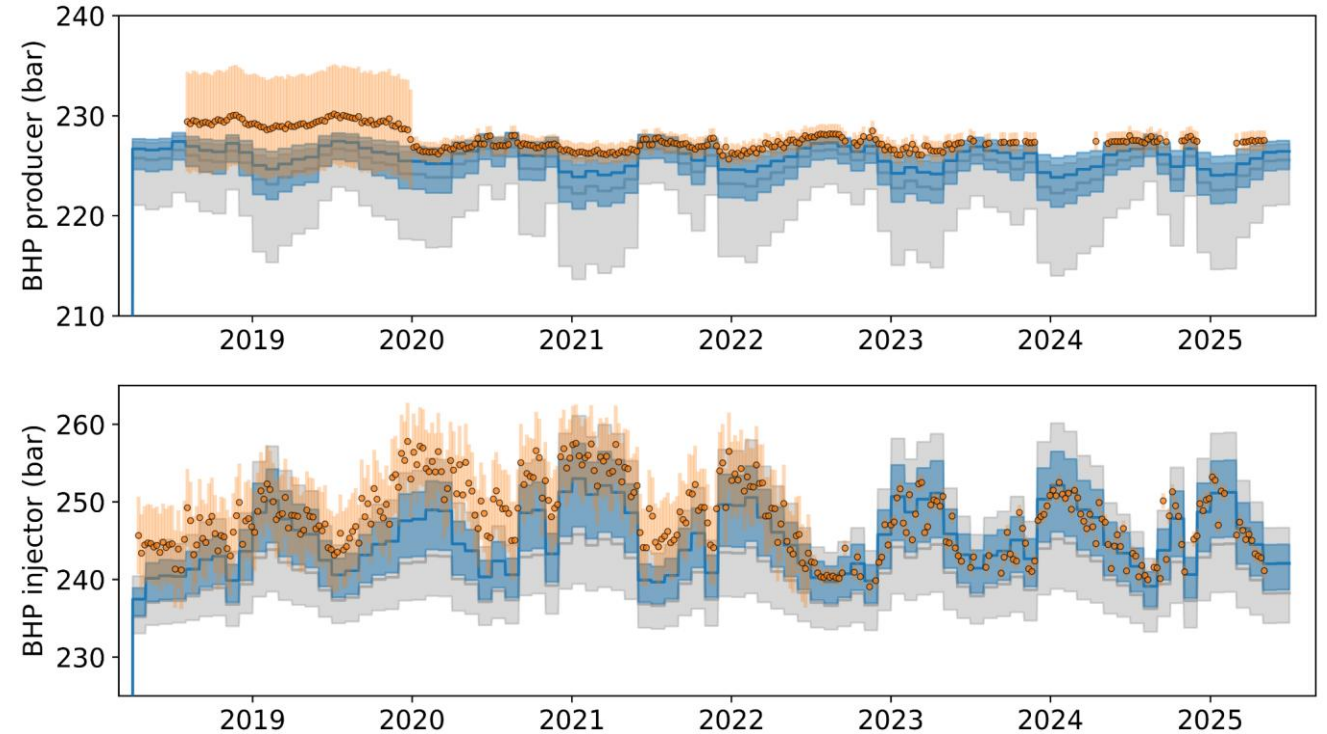
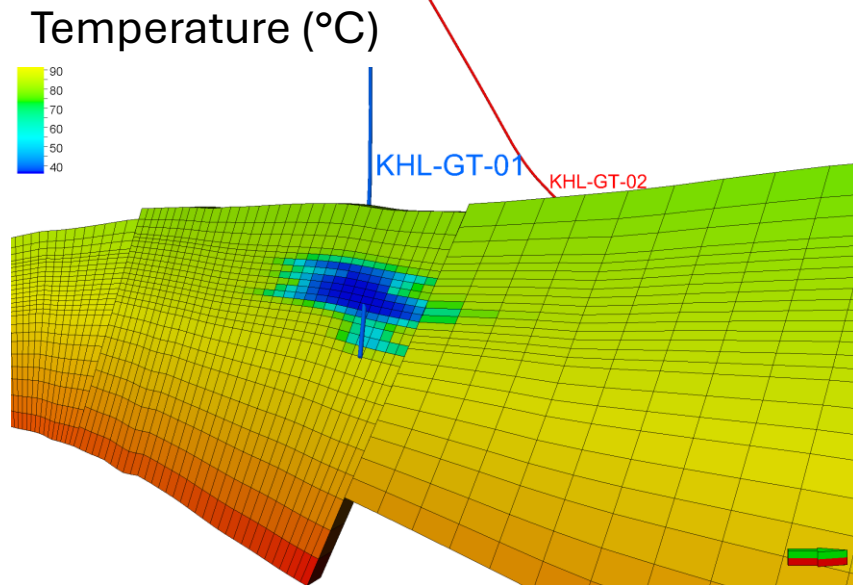
Highlight 2 Kwintsheul modeling



- Can we history-match the production data?
- What are the effects of incorporating realistic fault properties?
- Can we prove the fault is sealing?
- What does cooling do with fault stability (2027)?

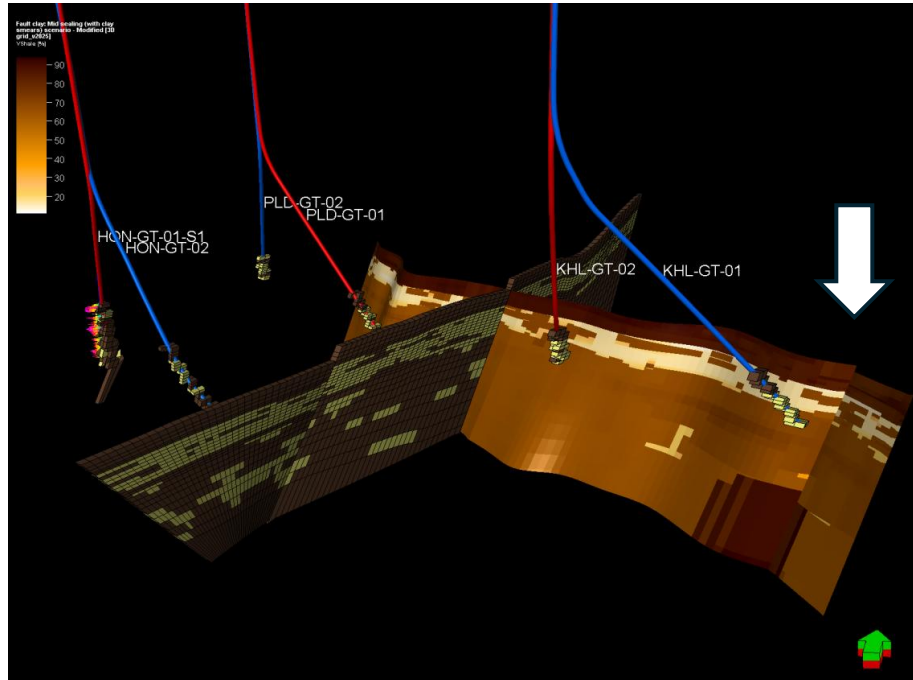


Highlight 2 Kwintsheul modeling



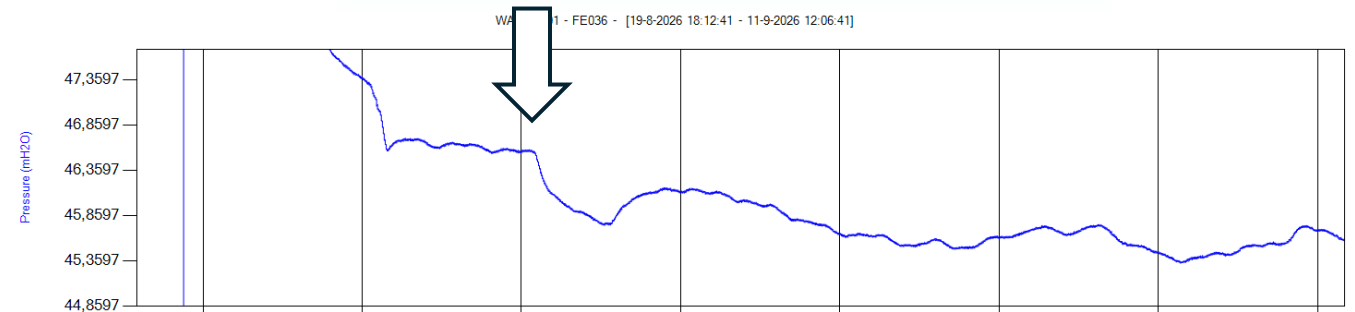
- History match successful. But the History Match based on wellhead pressure and temperature data provides little info on the fault transmissivity

Highlight 2 Kwintsheul modeling



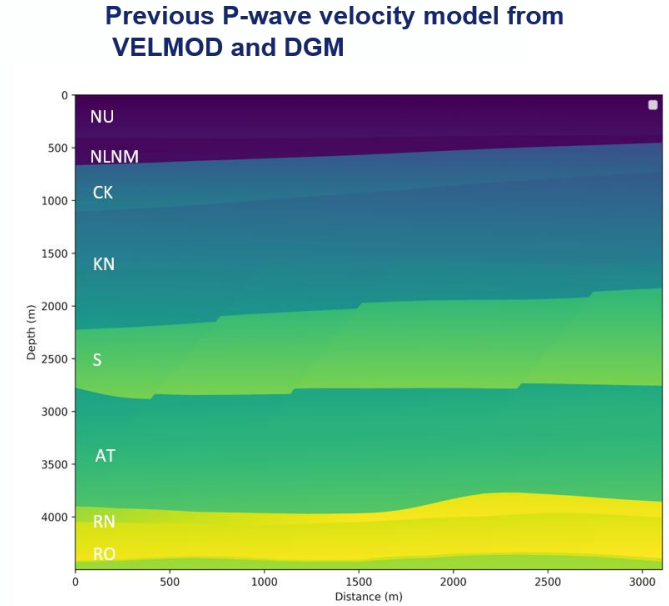
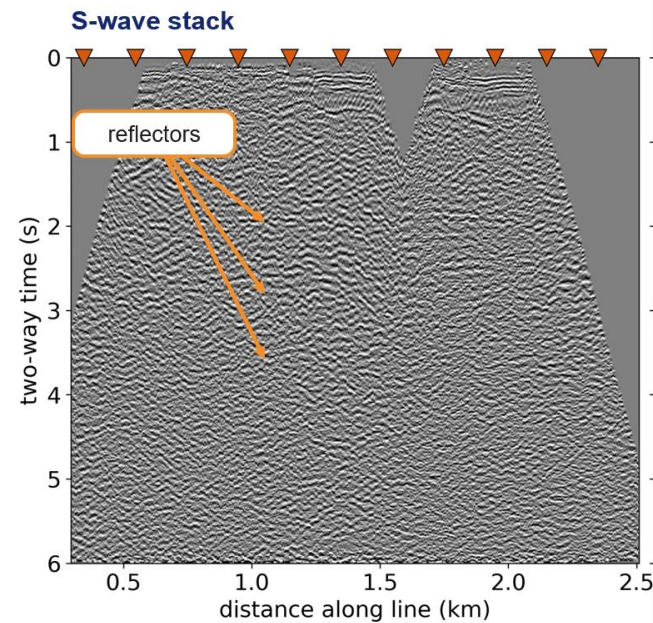
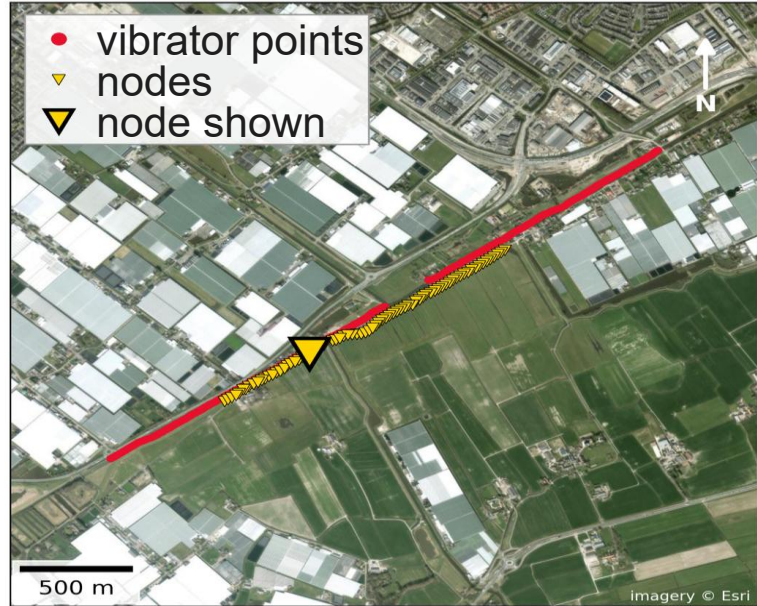
Pressure monitoring in
neighbouring well
Wippolder

Kwintsheul shut-down for workover



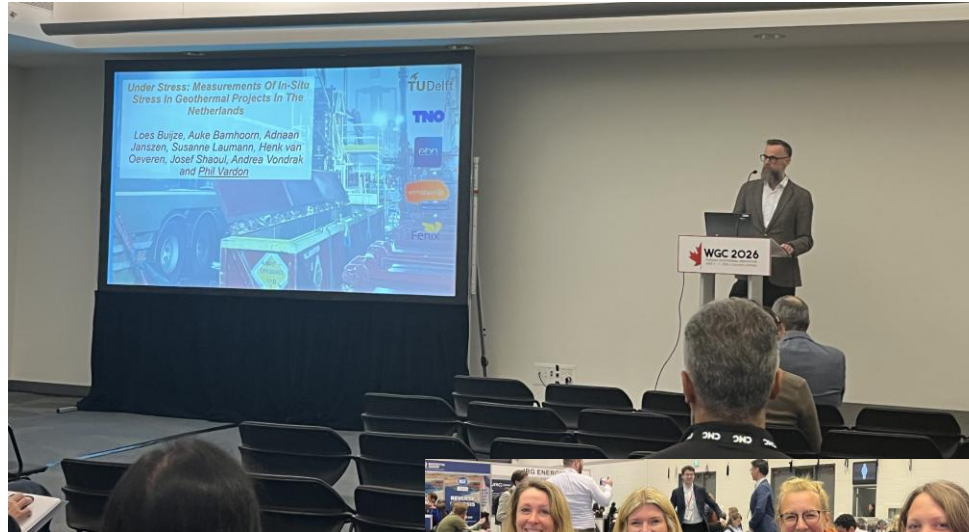
- Opportunity: HVC monitoring pressure in recently drilled well on other side of the fault
- Interference between wells across the fault gives more information, signal visible
- Analysis ongoing. Fault properties important for cold front evolution, optimal production, ..

Highlight 3 – S-wave velocity model



- S-wave signals can be used for imaging and velocity model (normally only P-wave signals)
- Better event localization

Dissemination



Proceedings World Geothermal Congress 2026
Calgary, Canada, June 8 – 11, 2026

Geothermal Production via Balanced Circulation in Sandstone Aquifers – Where do the Cold Fluids go?

L. Buijze^{1*}, E. Peters¹, H. Veldkamp¹, E. Calignano¹, H. van Oeveren², J. Reijs³ and A. Vondrak²
Geological Survey of the Netherlands, TNO, Utrecht, the Netherlands^{1*}, Ennatuurlijk Aardwarmte, Middenmeer, the Netherlands², Gaia Energy, Schiphol, the Netherlands³

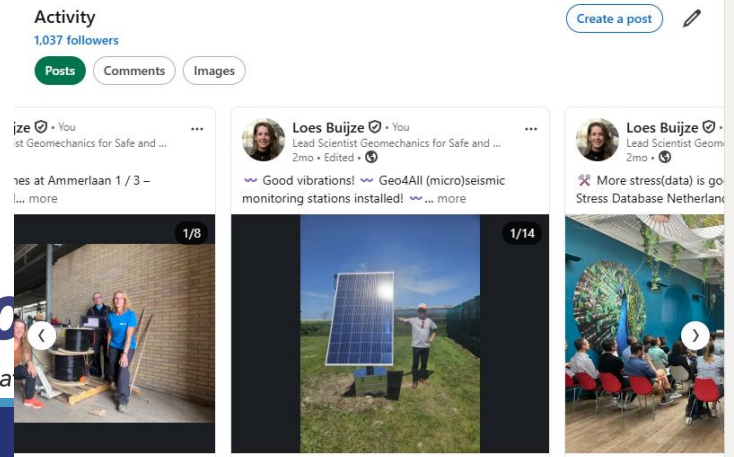
WGC Article Geothermal Production via Balanced Circulation in Sandstone Aquifers – Where do the Cold Fluids go?

Proceedings World Geothermal Congress 2026
Calgary, Canada, June 8 – 11, 2026

WGC Article Under Stress: Measurements of in-situ Stress In Geothermal Projects In The Netherlands

Andrea Vondrak^{4*} and Philip J. Vardon^{4*}

TNO, the Netherlands¹, TU Delft, the Netherlands^{2*}, EBN, the Netherlands³, Ennatuurlijk Aardwarmte⁴, Fenix Consulting Delft, the Netherlands⁵



- Geothermal Forum 2026
- EGC papers published
- WGC 2026
- SSA meeting
- EAGE Aberdeen
- GNL Website
- LinkedIn posts and series
- ...

Outlook next year

- Second stress test in uncooled reservoir @ Middenmeer + modelling
- Continuous monitoring
- Instrumentation 1.8 km deep well Bleiswijk (VDB-GT-04)
 - Need support of SodM
 - Delay of abandonment request
 - Essential for research objectives and use for the sector
- Kwintsheul & Bleiswijk modelling
- WP dinners..

And.. **TKI CoolIT!** Awarded Q1 2026.
DTS measurements to further constrain cooling
See **Parallel Session #3 DTS**





Jul 08, 2026 12:24:00 12:24:20 12:24:40 12:25:00 12:25:20