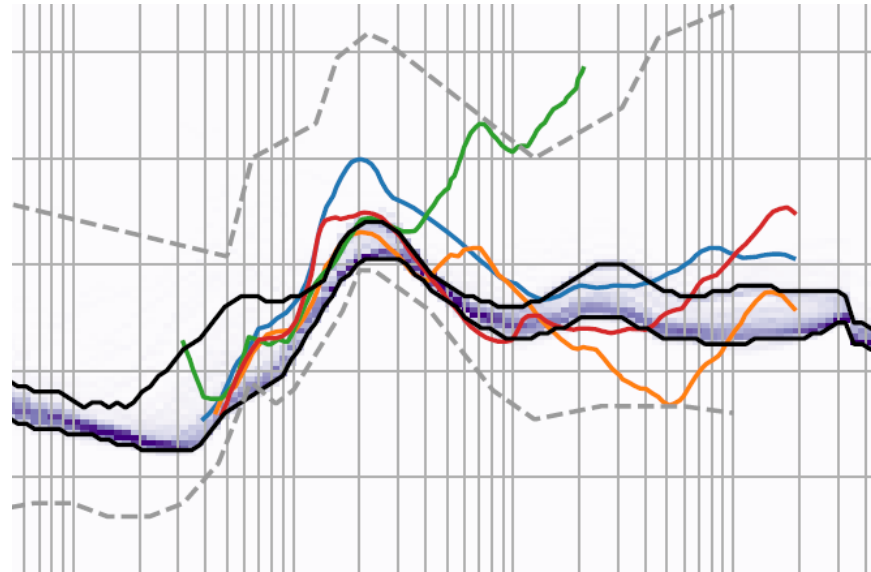


Seismic noise characterisation at ET candidate sites

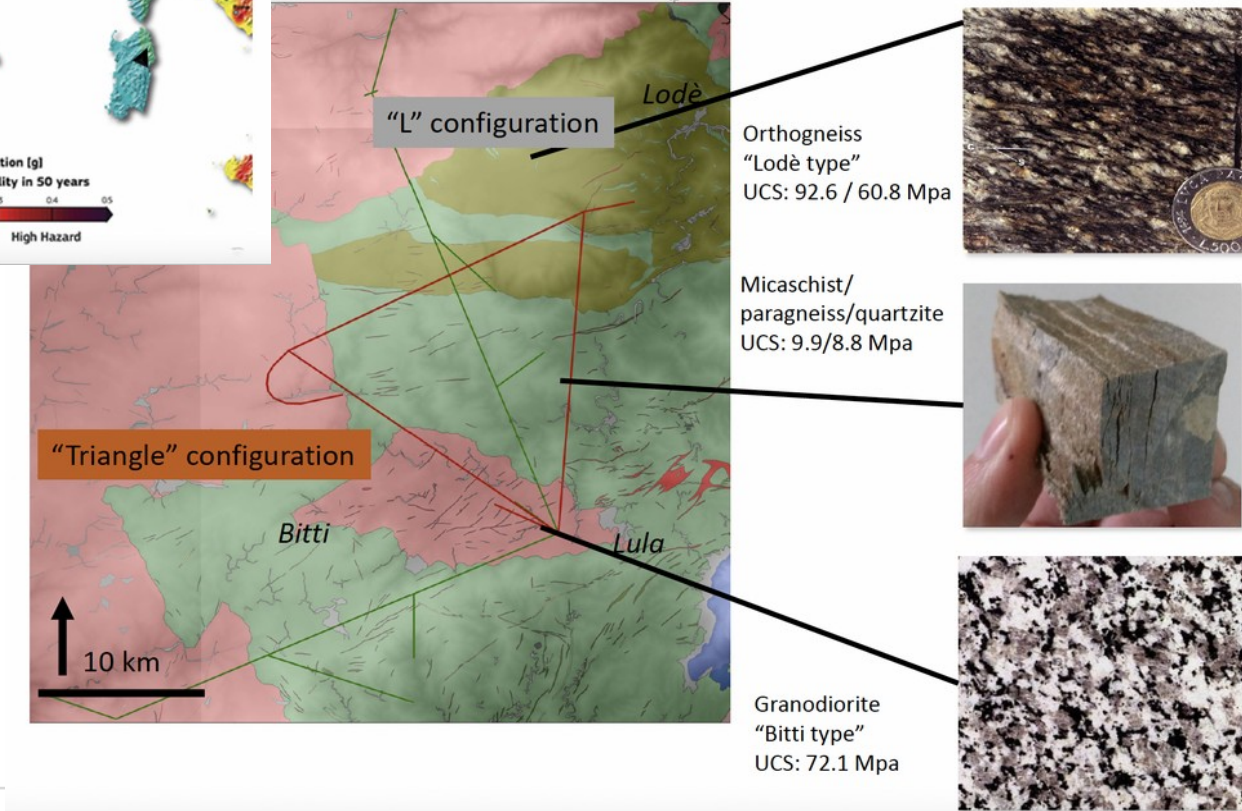
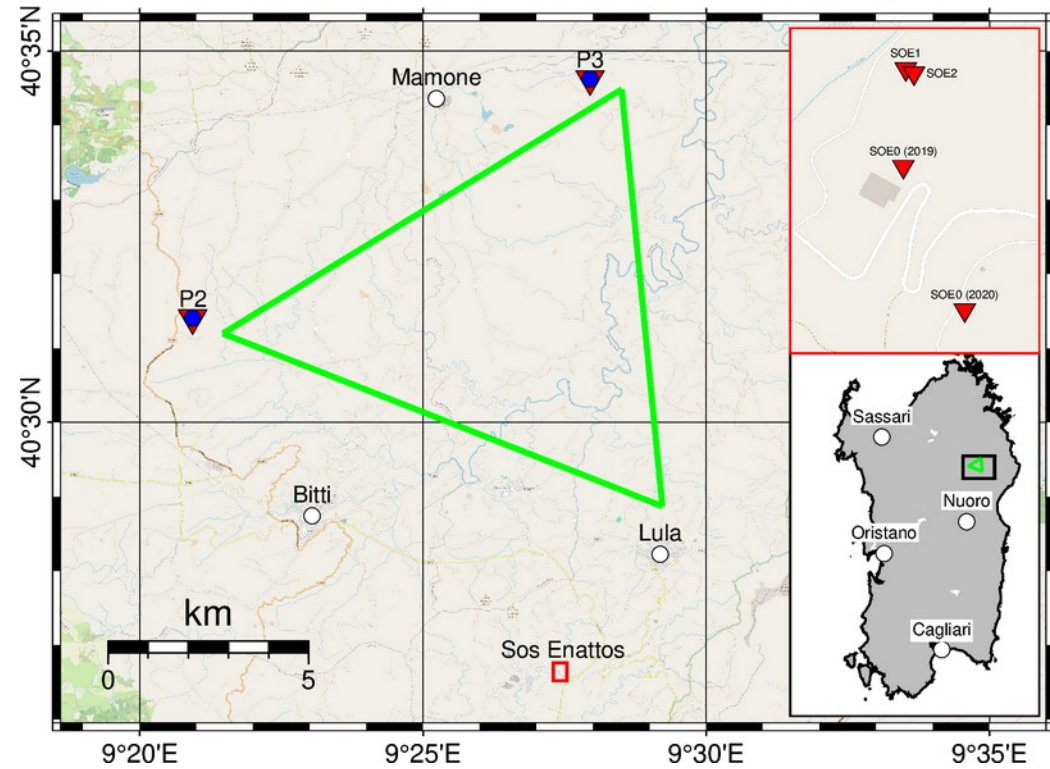
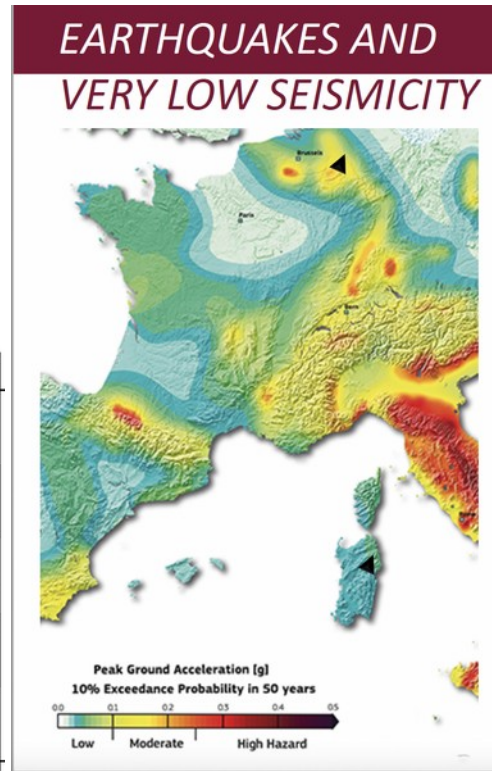
Andreas Rietbrock¹, Michael Frietsch¹, Carlo Giunchi², Thomas Forbriger¹, **Mike Lindner**¹, Matteo Di Giovanni³, Luca Naticchioni⁴, Shani Kadmiel Shahr⁵ (¹KIT, ²INGV, ³INFN, ⁴GSSI, ⁵KNMI)

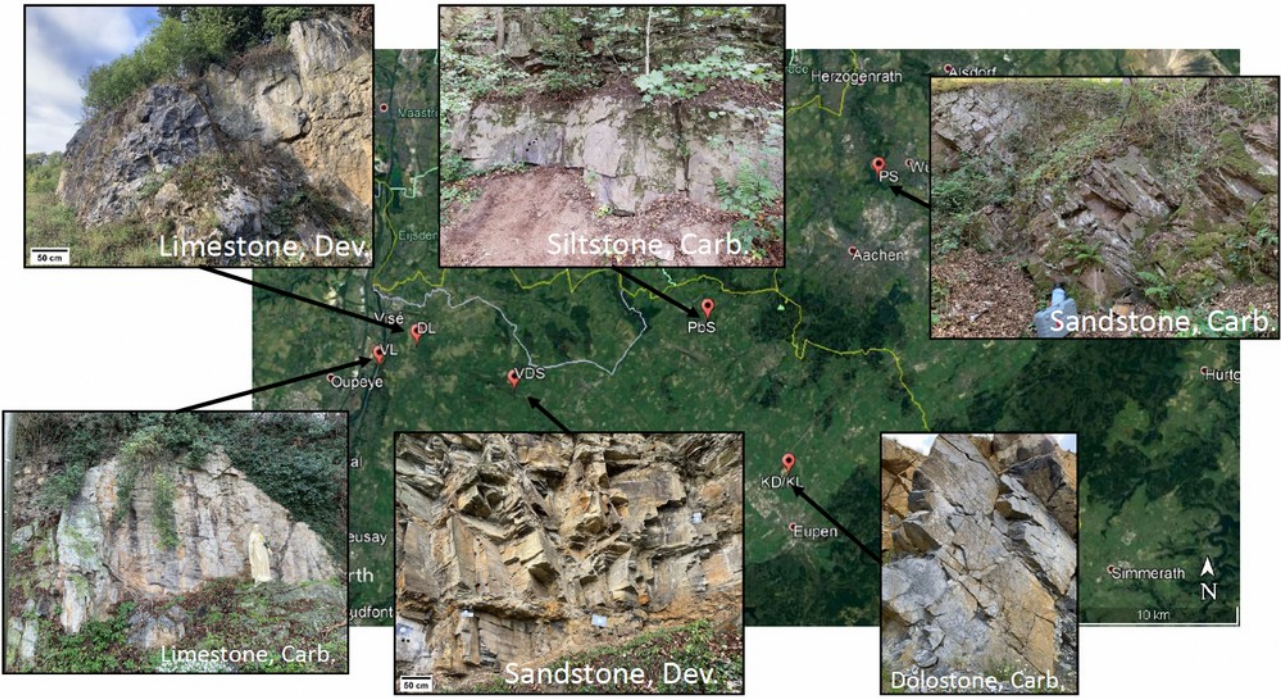
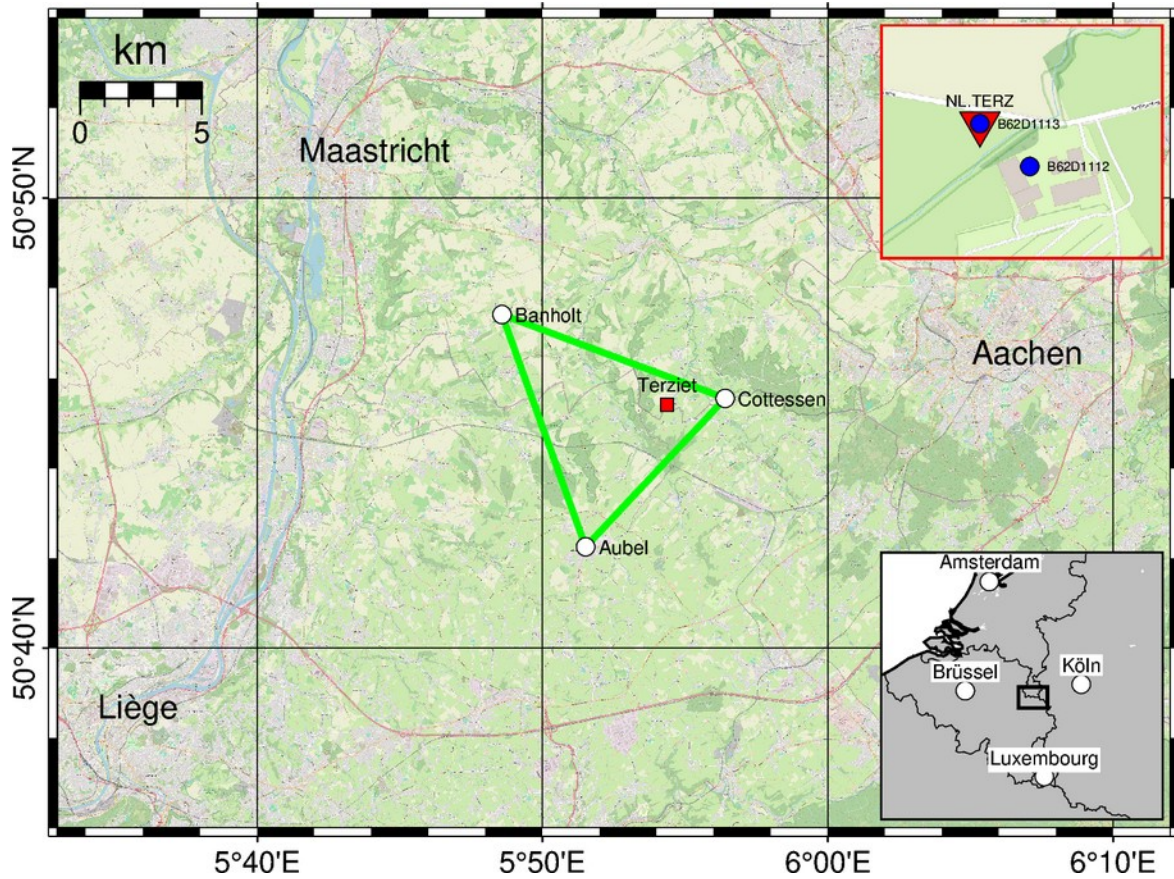


Outline

- **Proposed ET candidate sites in:
Sardinia, Euregio-Meuse-Rhine (EMR) and Lausitz**
- Comparison of seismic noise observations
- Conclusions / Outlook

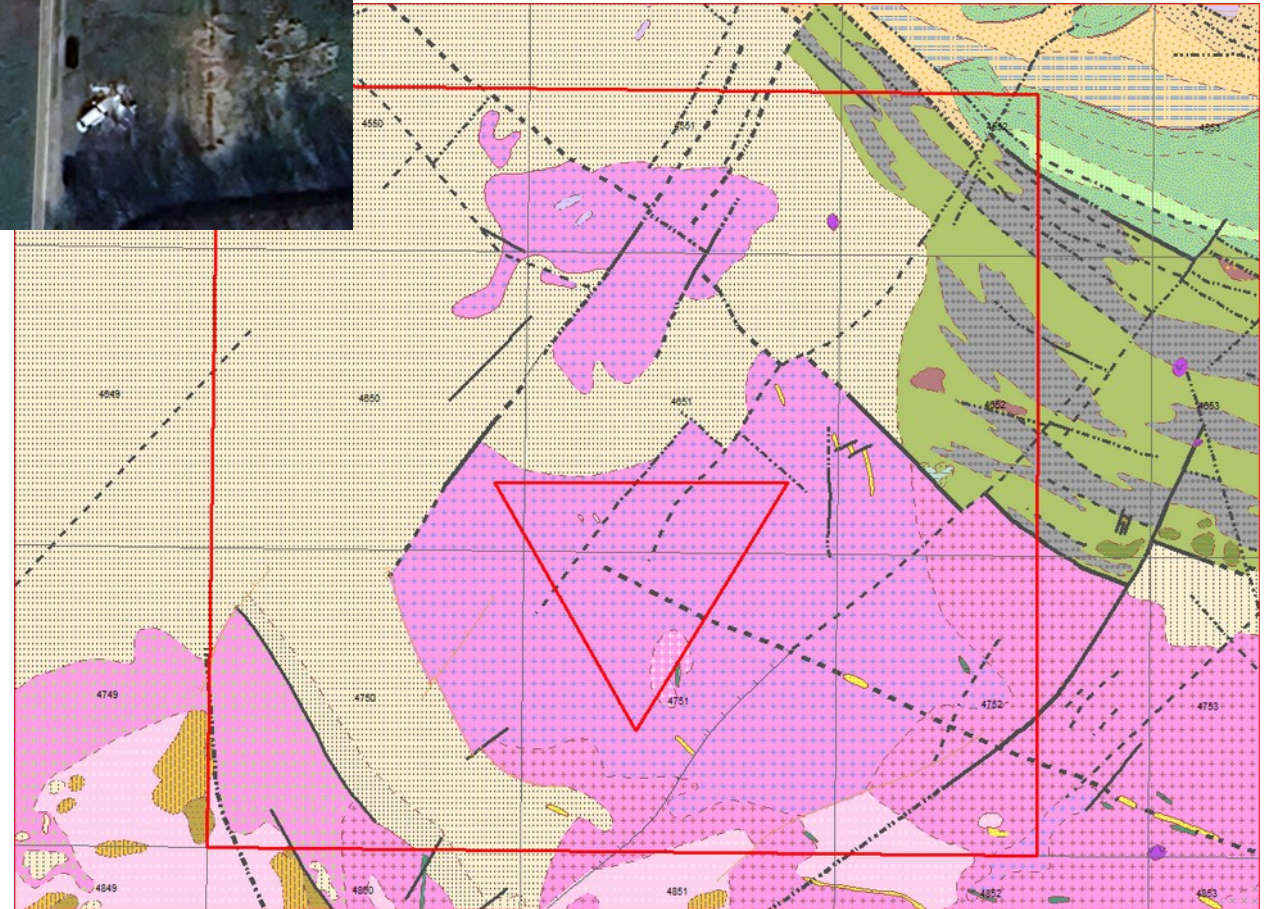
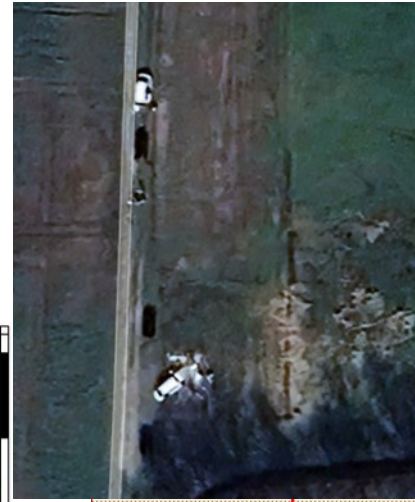
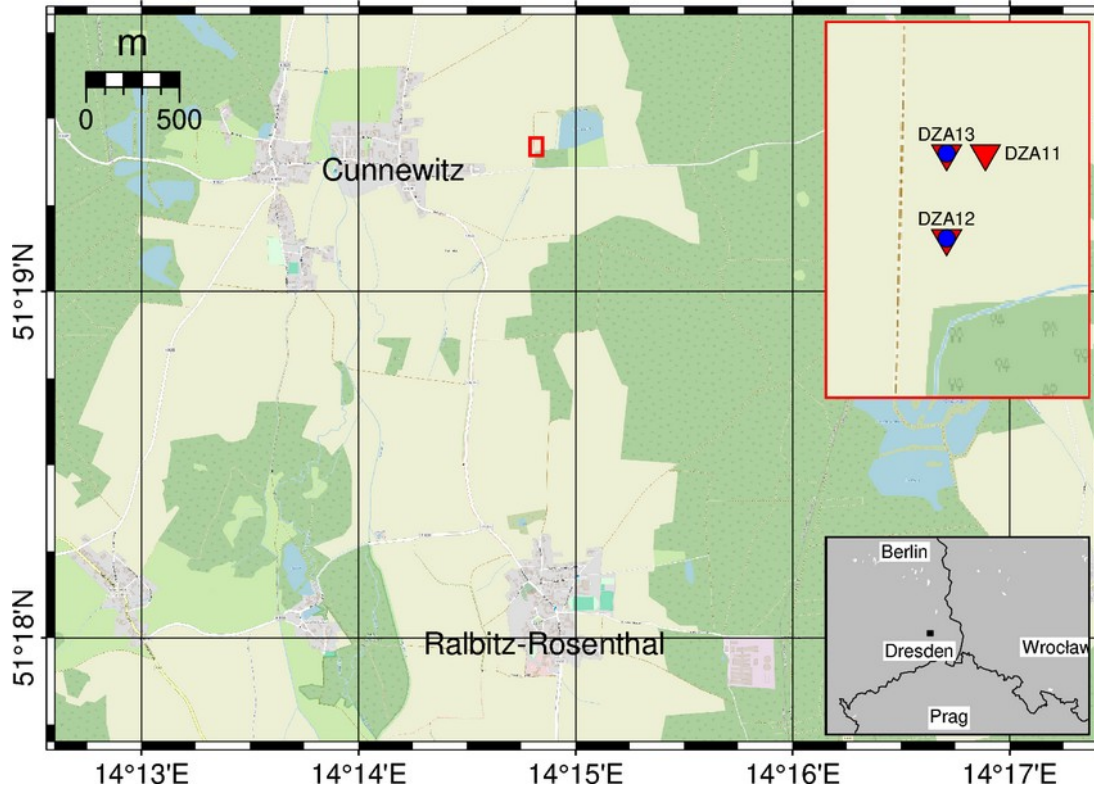
Sardinia



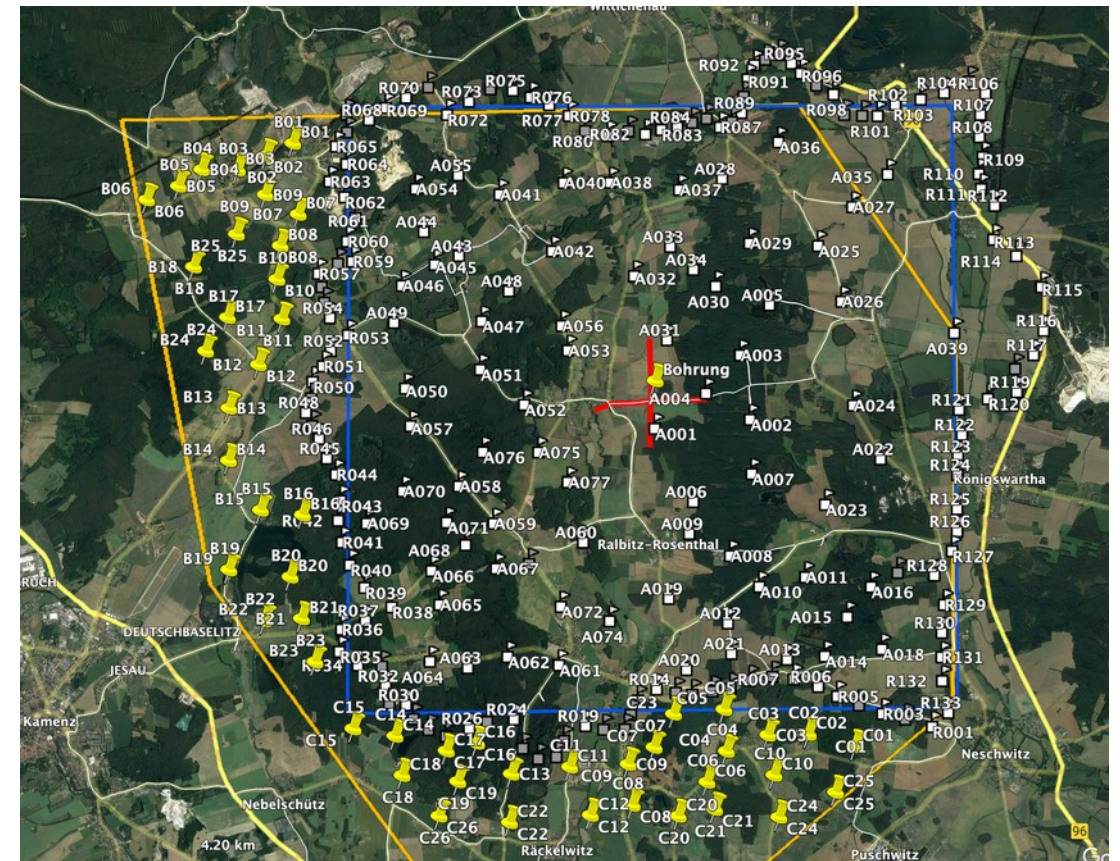
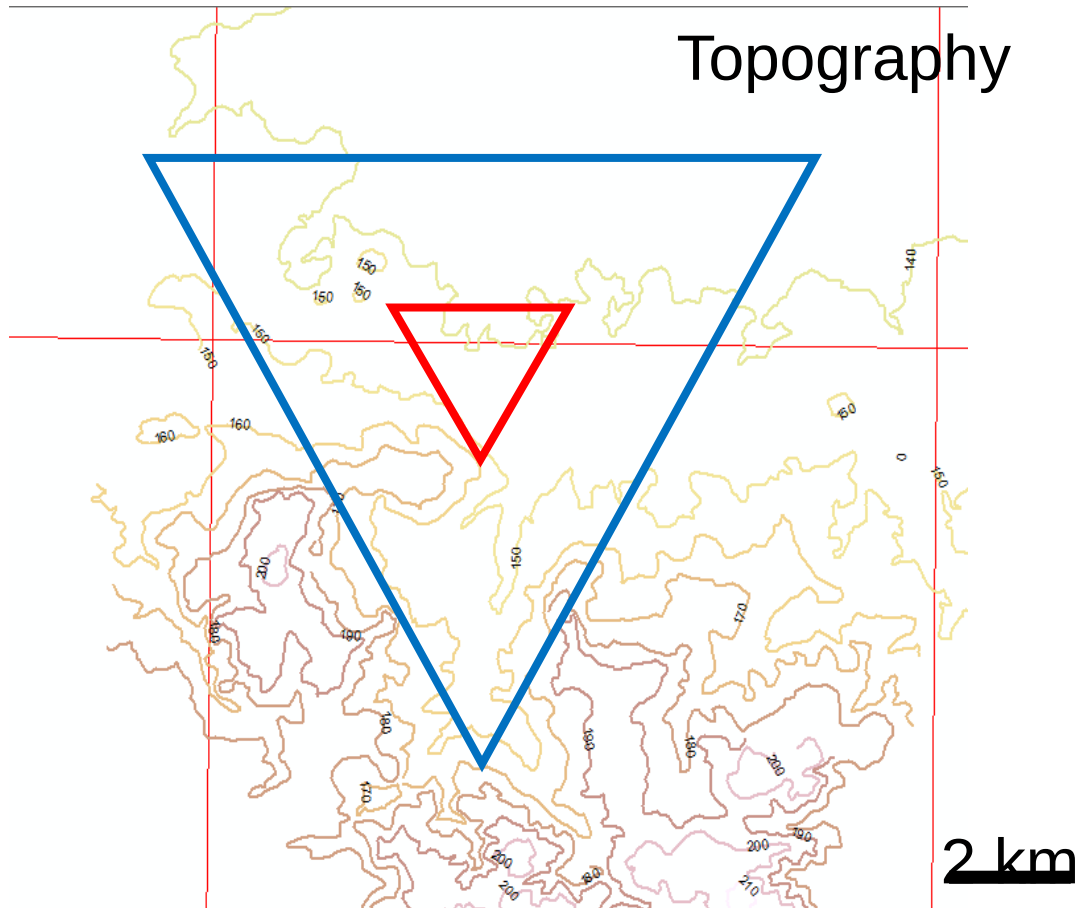


<https://www.dinoloket.nl/en/subsurface-data-beta>

Lausitz

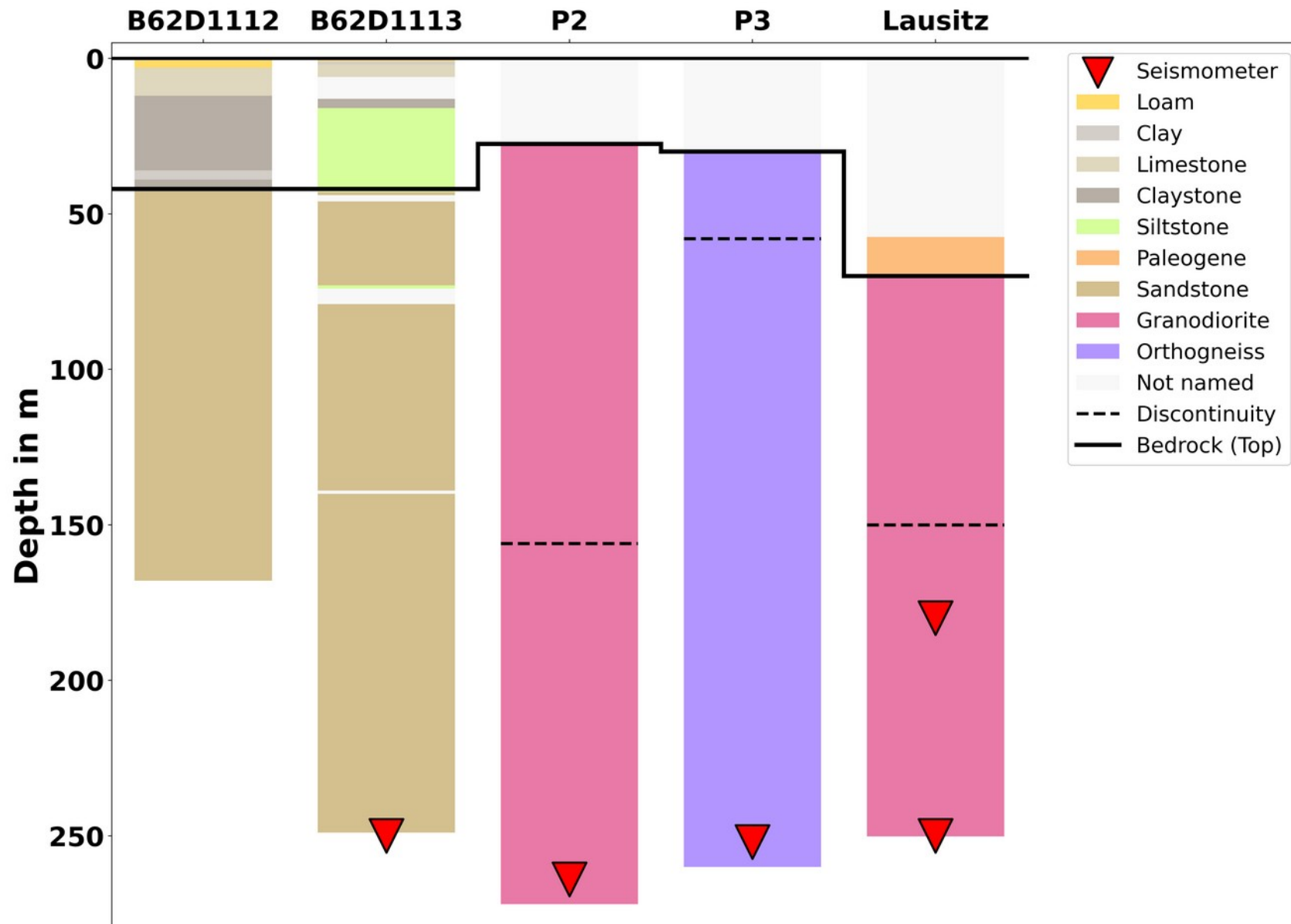


3C station deployment Dec23-Feb24



Deployment of approx. 250 seismic stations

Borehole logs



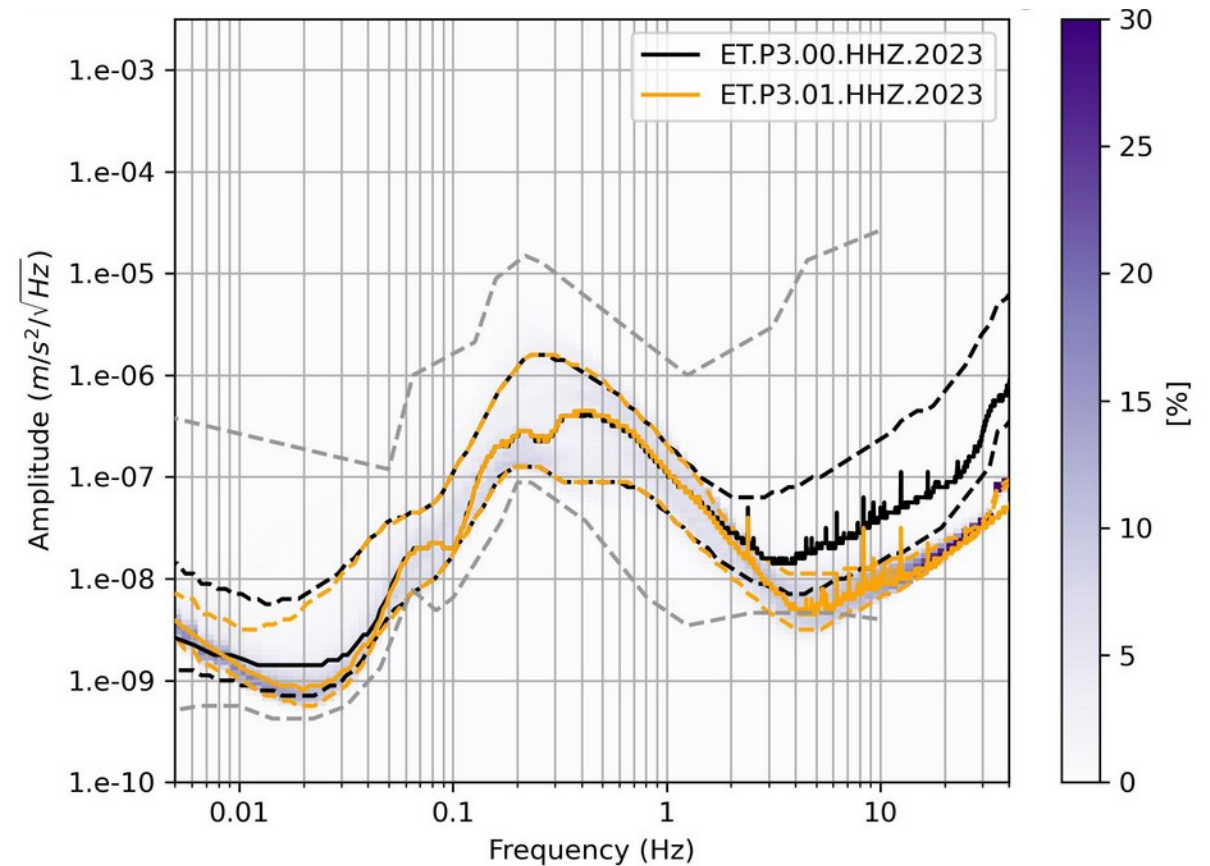
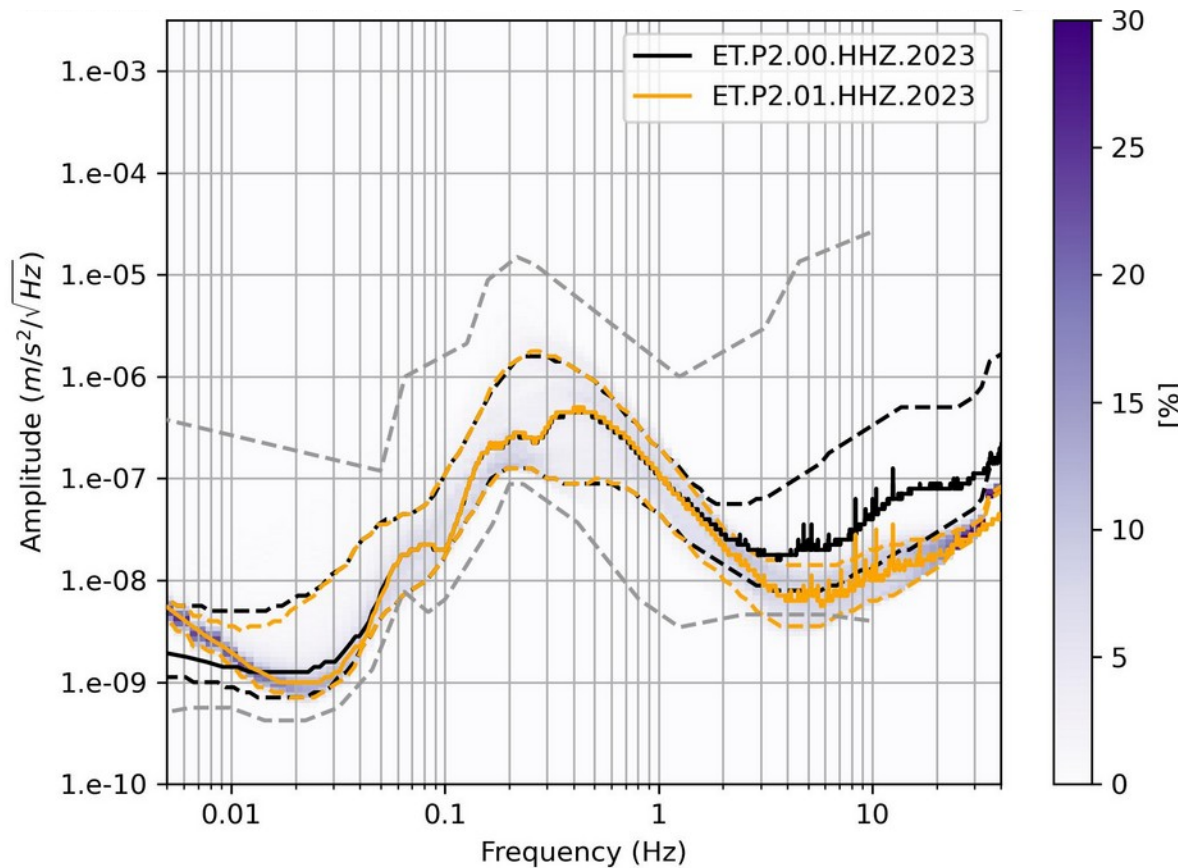
Outline

- Proposed ET candidate sites in:
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- **Comparison of seismic noise observations**
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Sardinia – Comparison surface to borehole

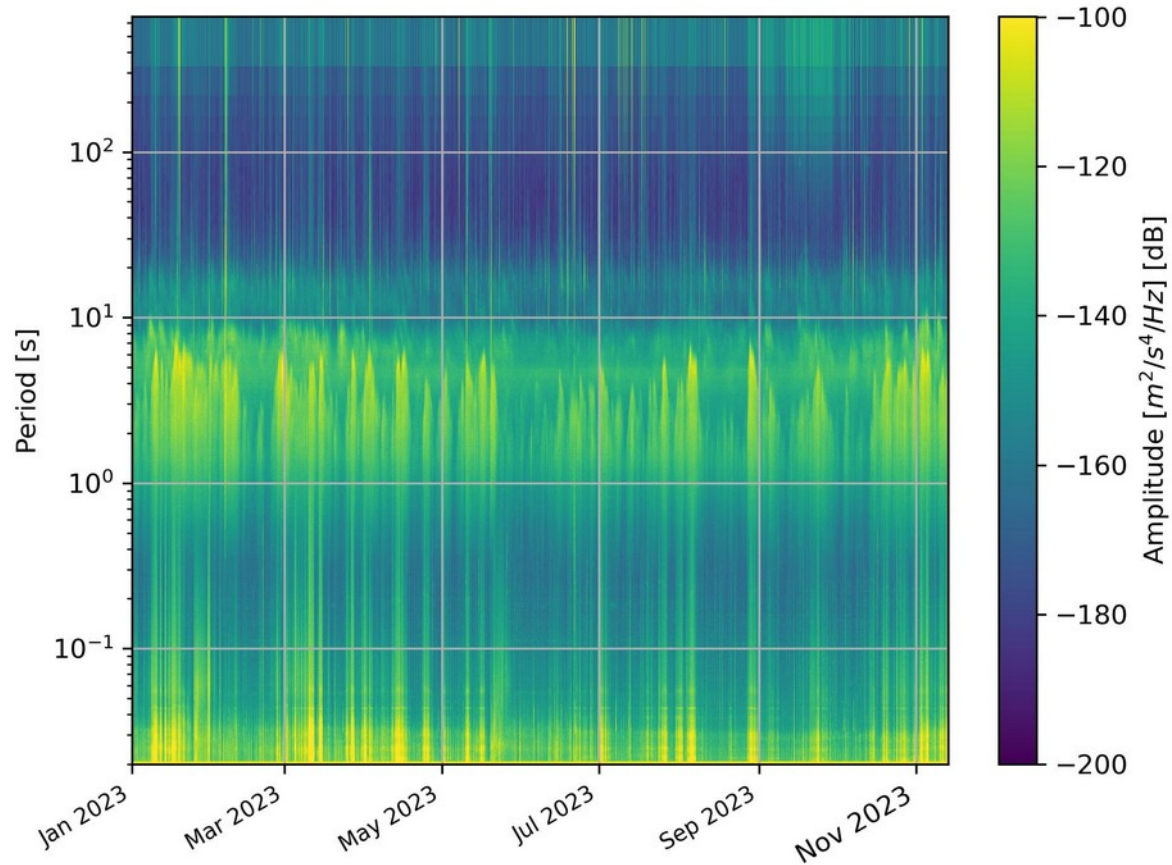
Station P2

Station P3

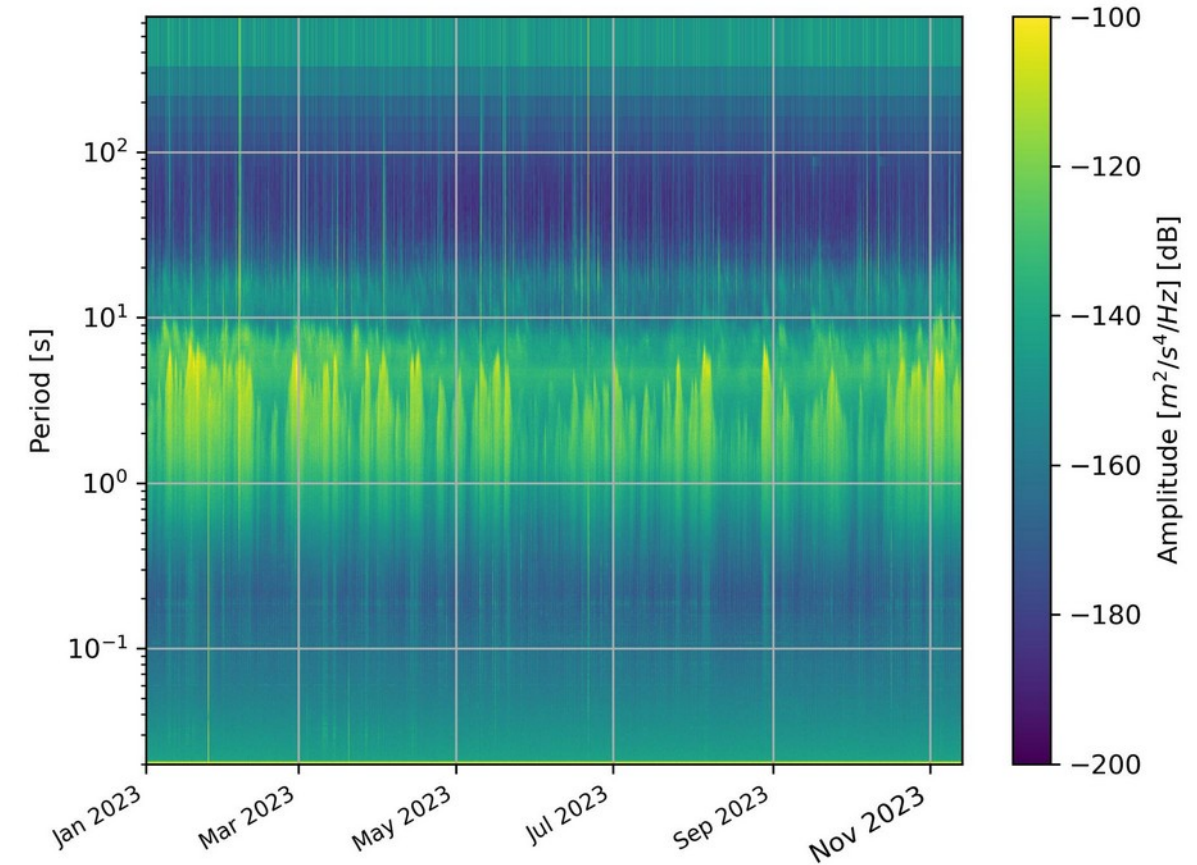


Sardinia – Comparison surface to borehole

Station P3 surface

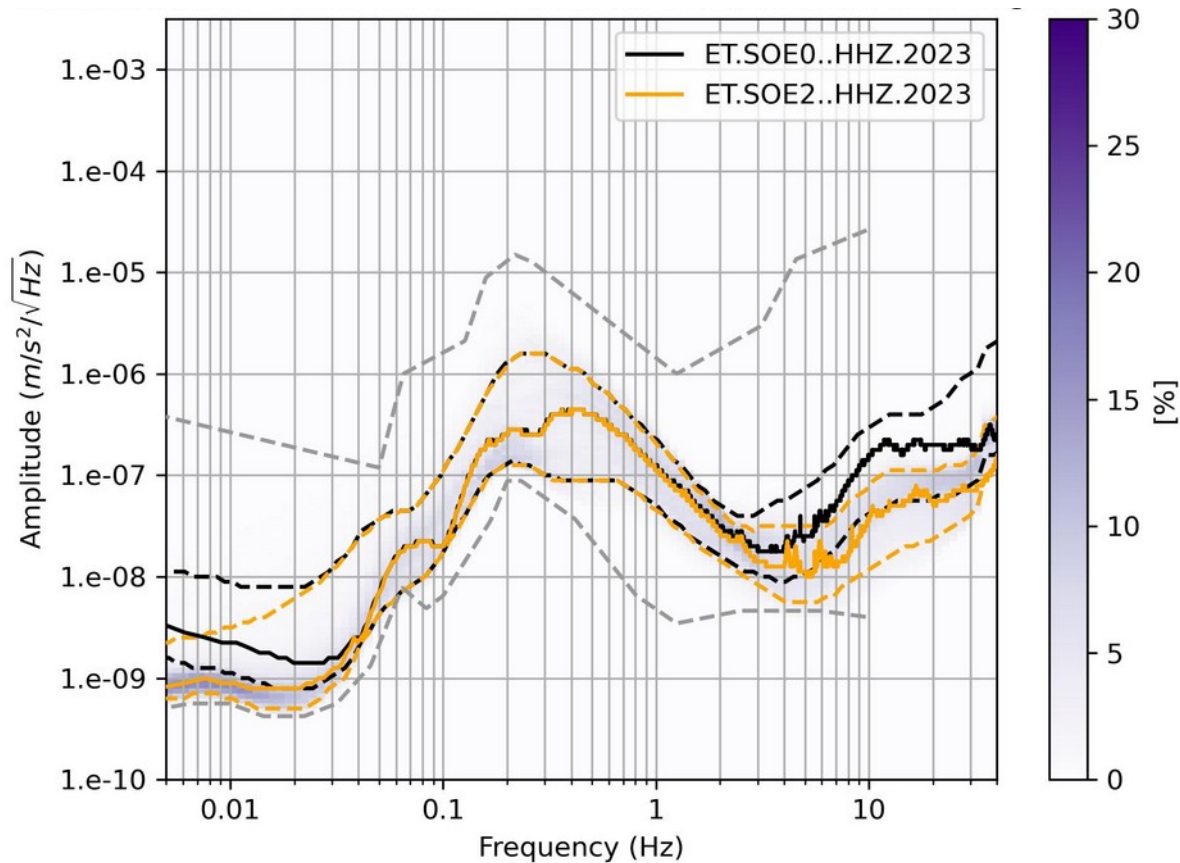


Station P3 borehole

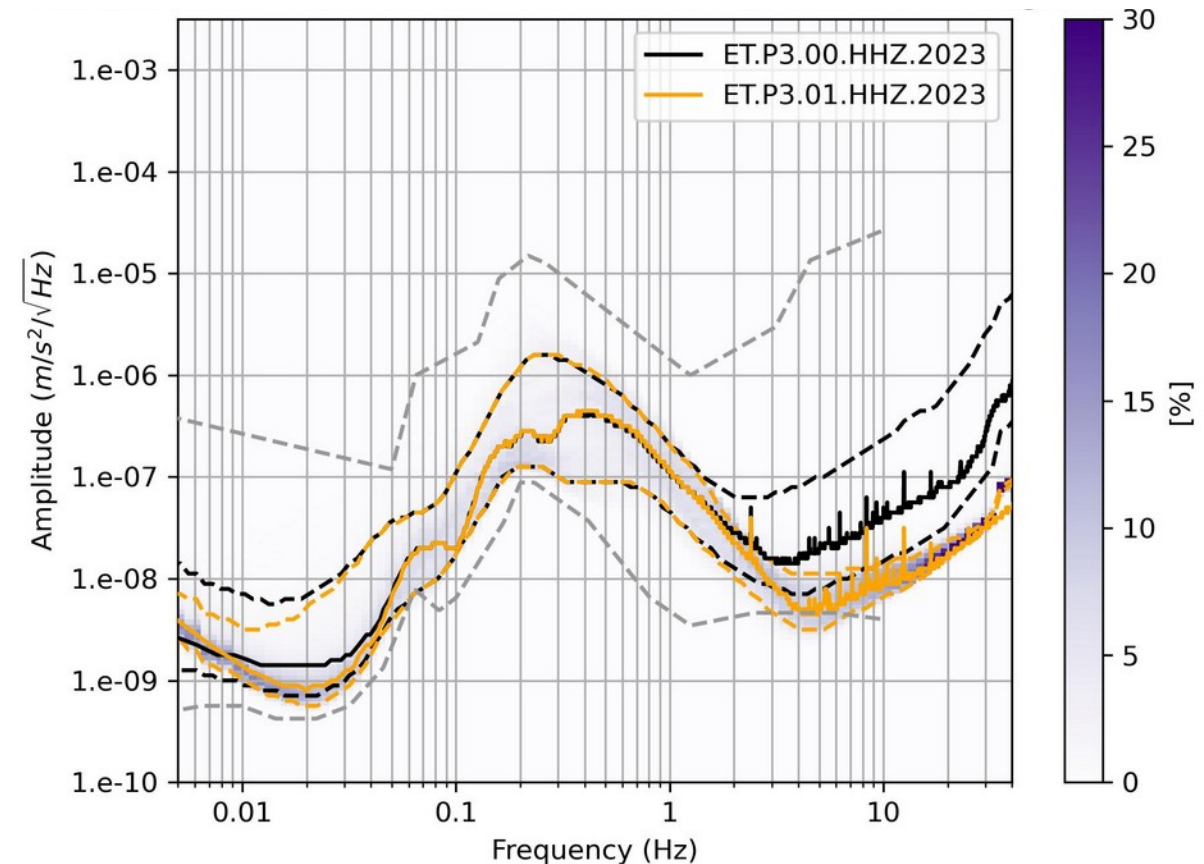


Sardinia – Comparison Sos Enattos Mine to P3

Sos Enattos Mine



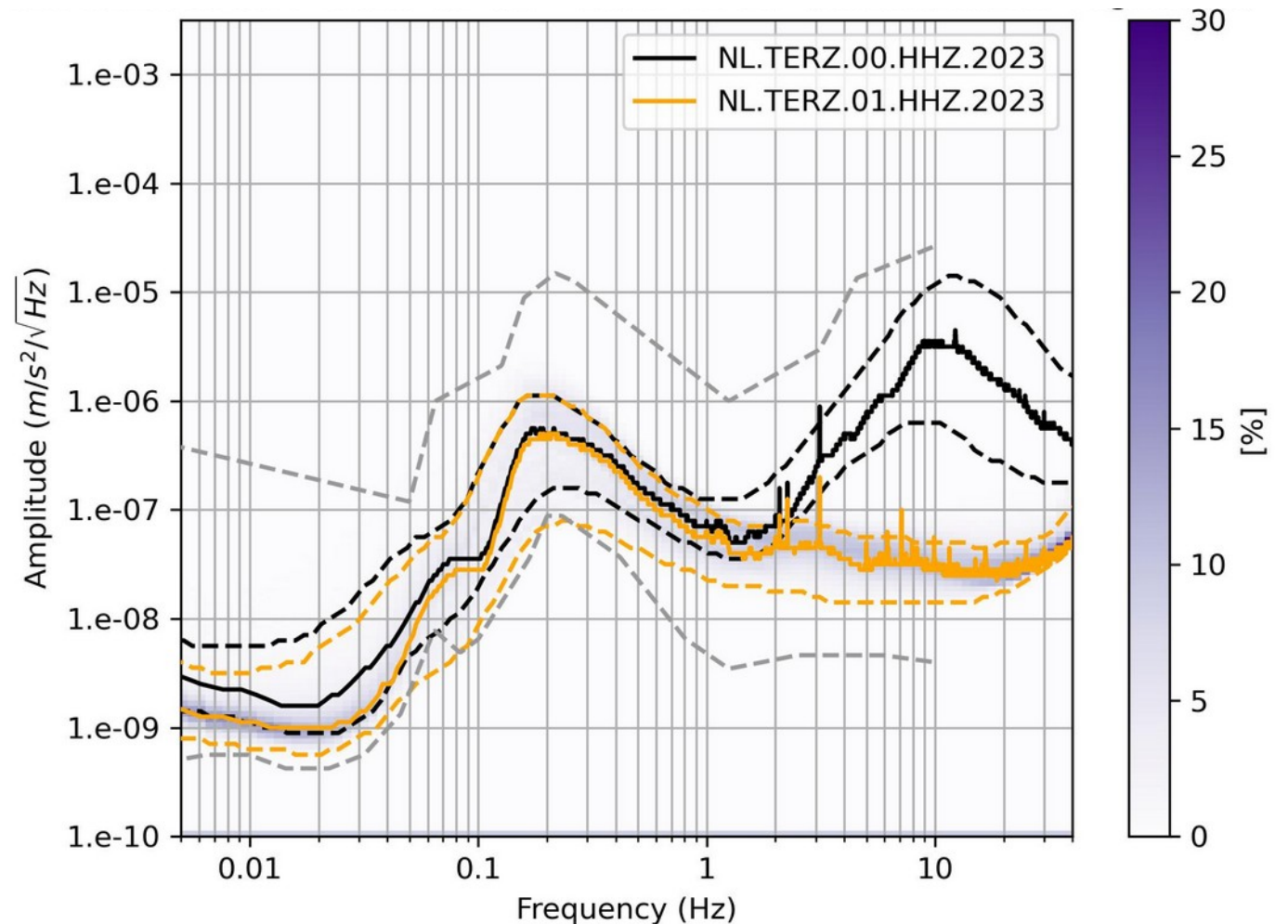
Station P3



EMR - Comparison surface to borehole

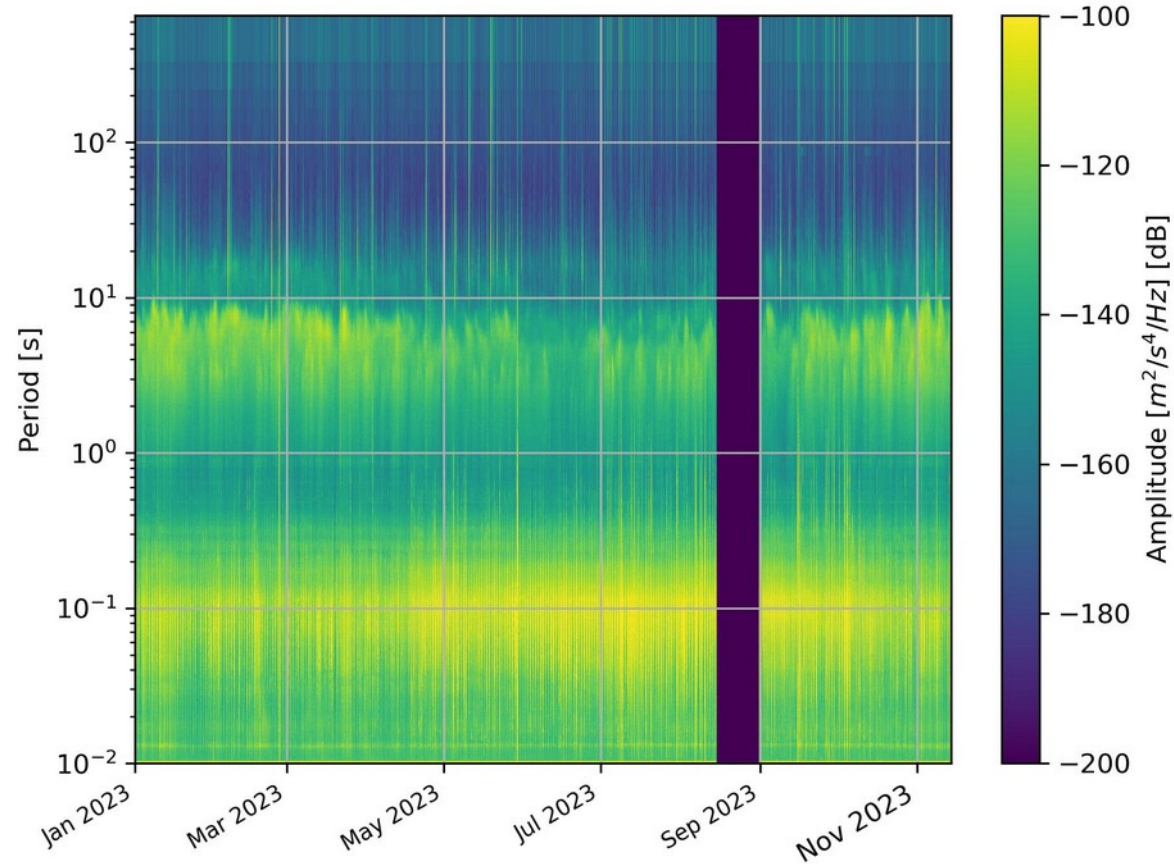
Borehole and surface data for the whole year 2023

Borehole station with lower amplitudes (100 at 10Hz), especially for frequencies higher 2 Hz

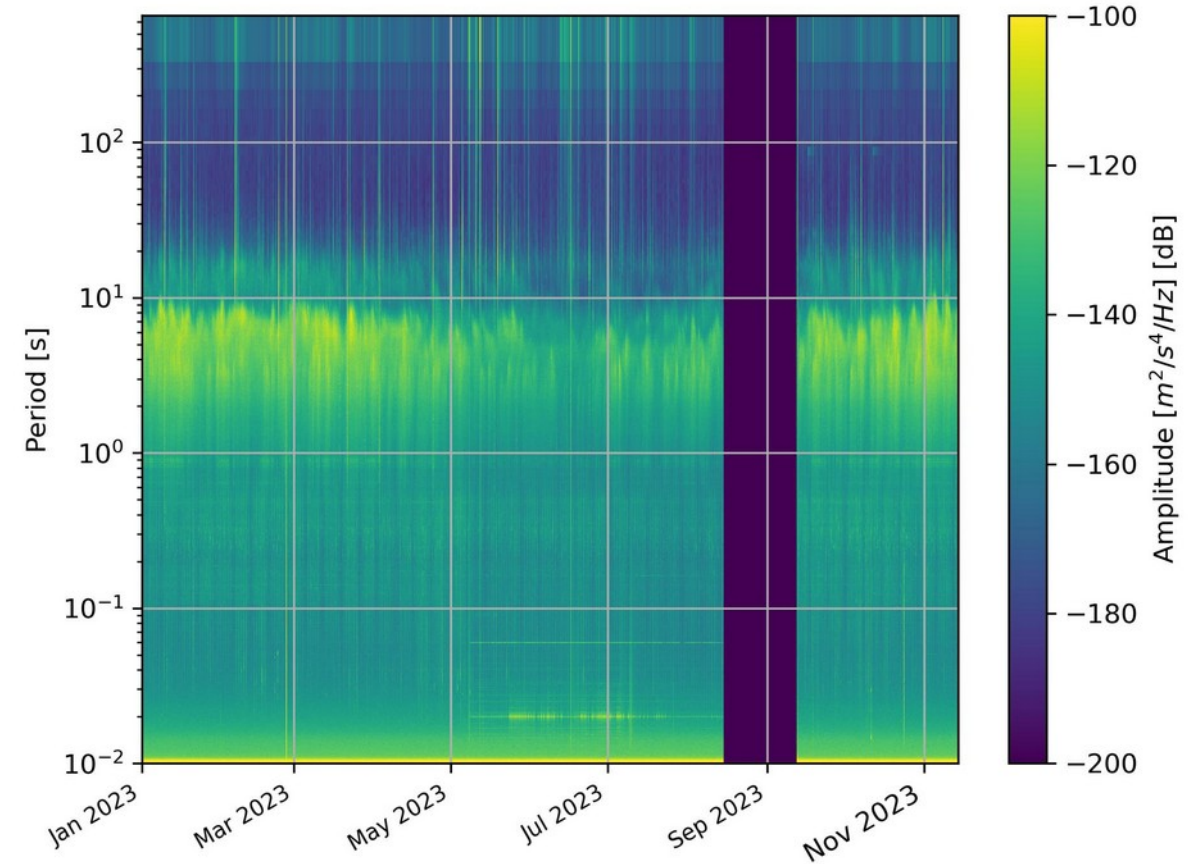


EMR - Comparison surface to borehole

TERZ - surface

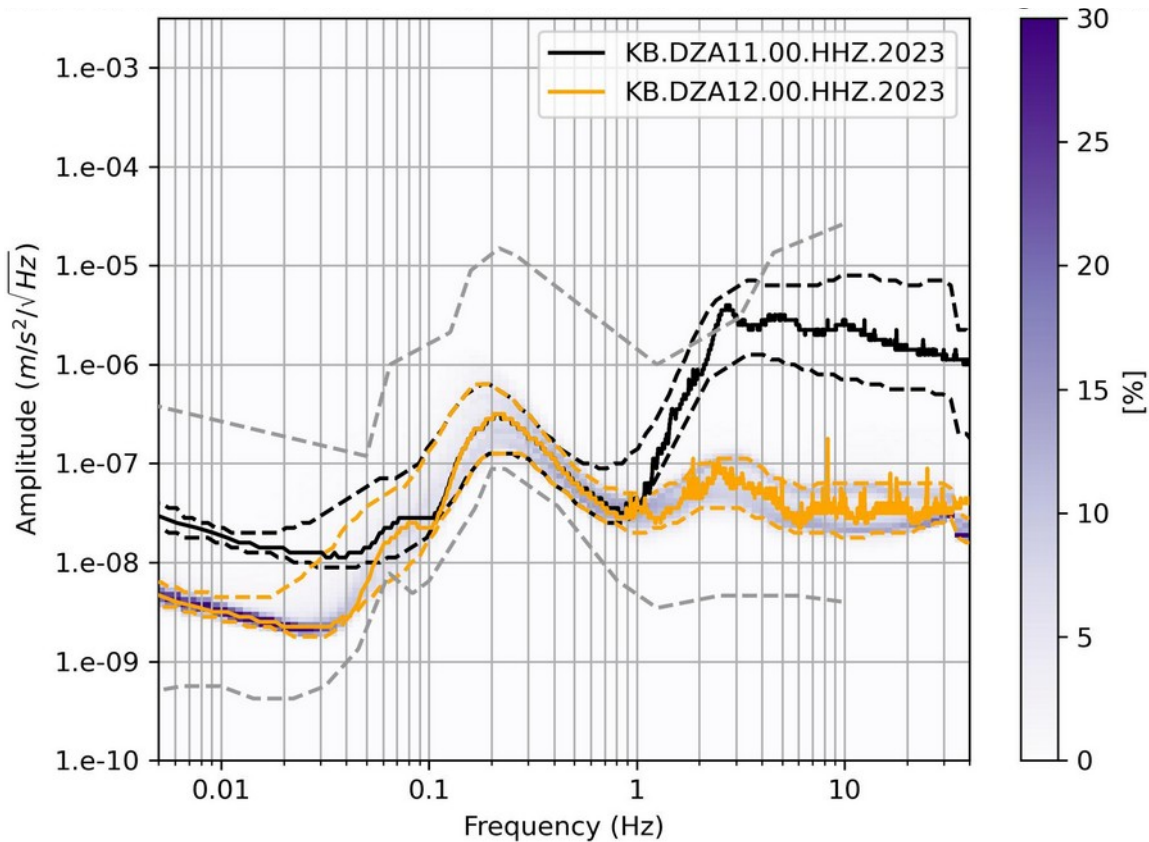


TERZ - borehole

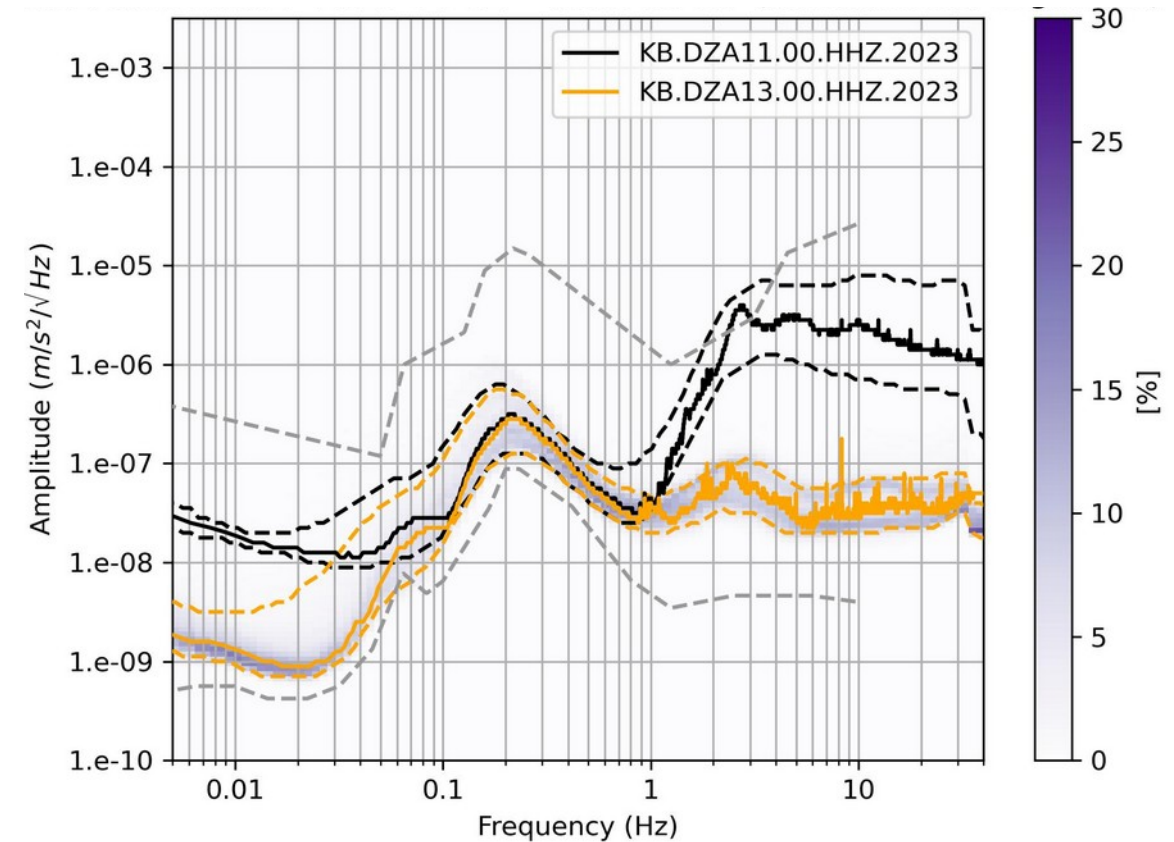


Lausitz – Comparison surface to borehole

DZA11 v.s. DZA12

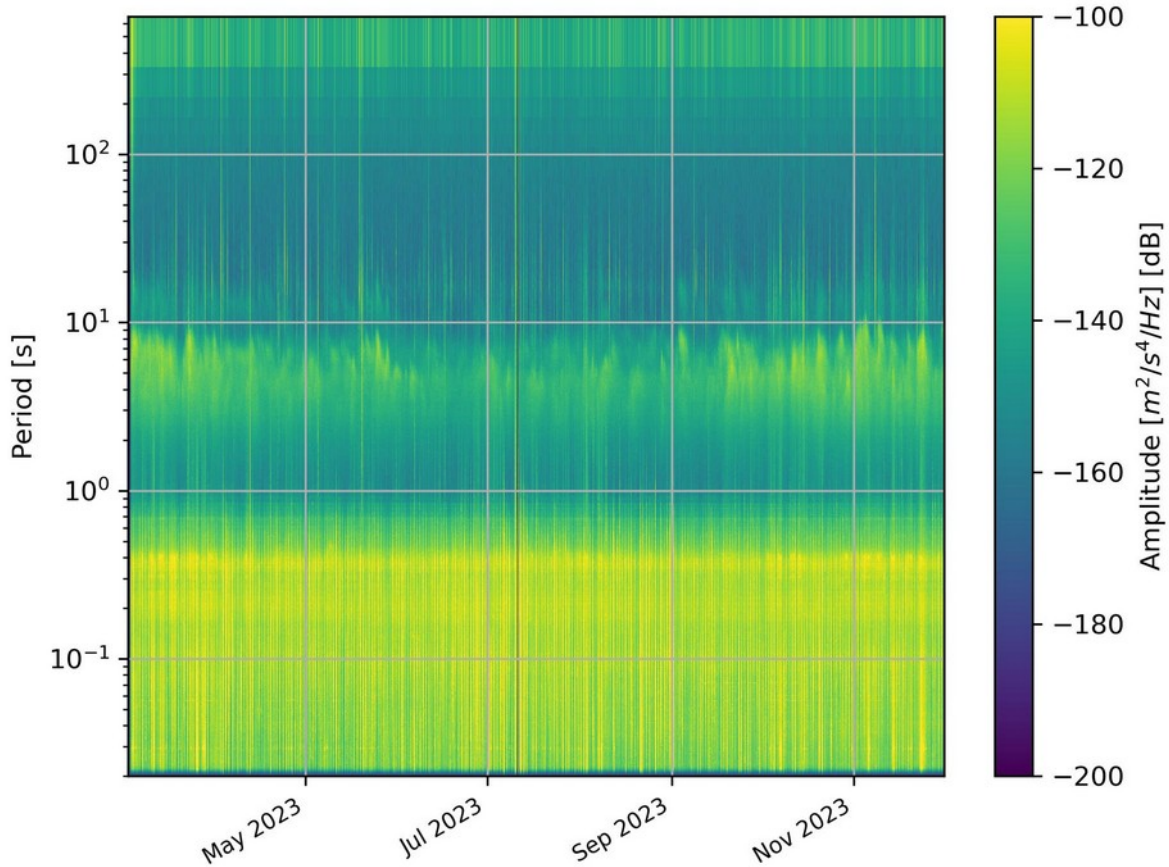


DZA11 v.s. DZA13

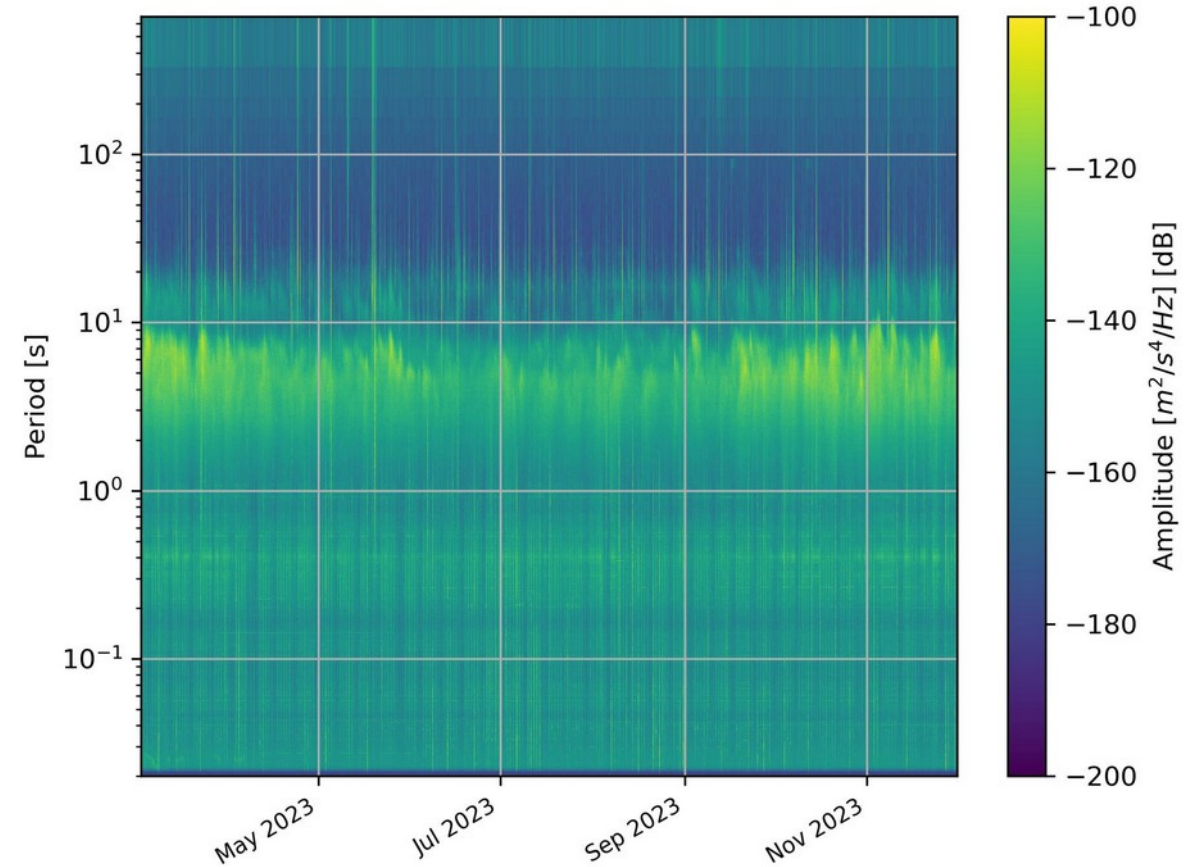


Lausitz – Comparison surface to borehole

DZA11 - surface

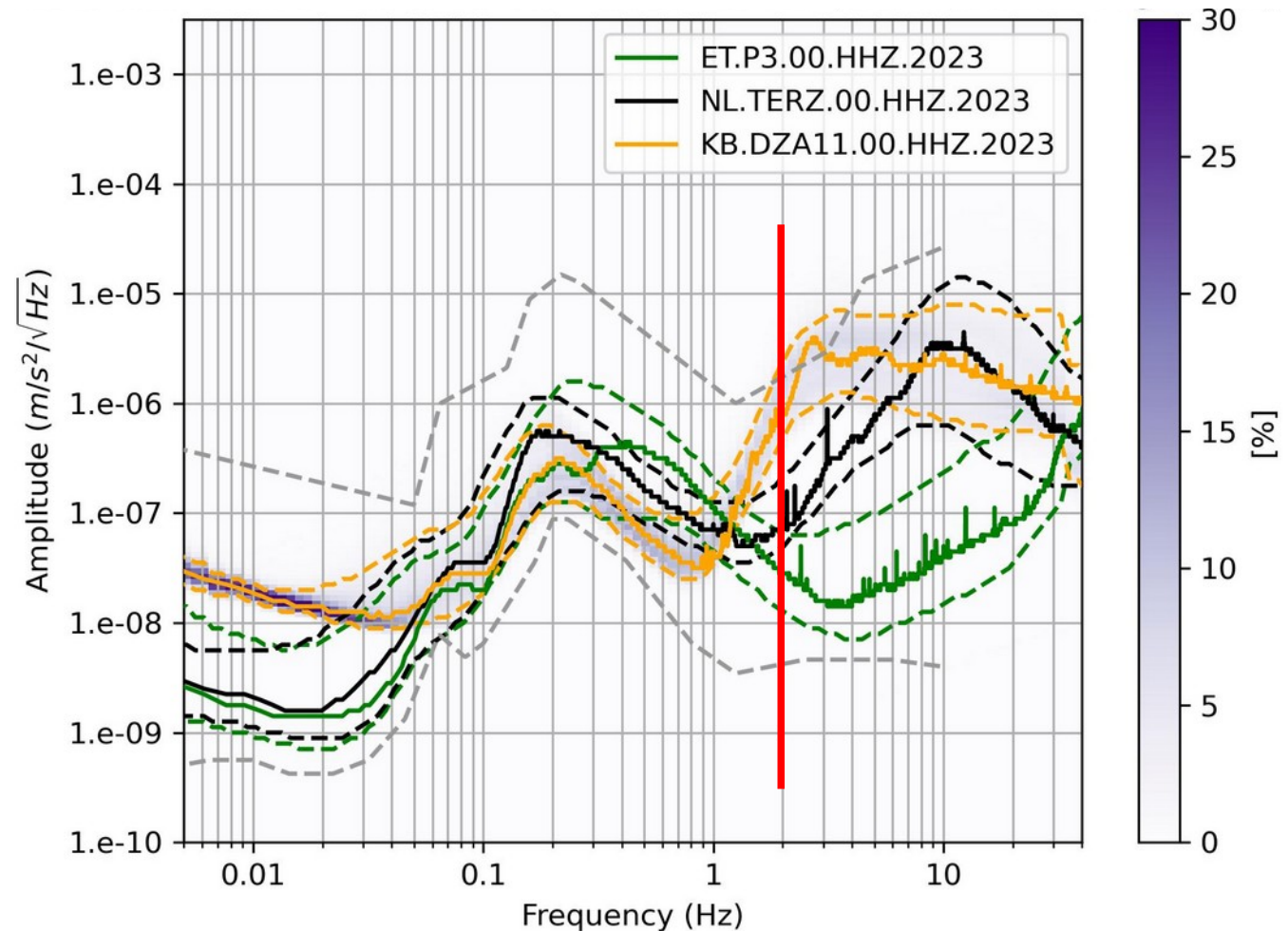


DZA12 - borehole



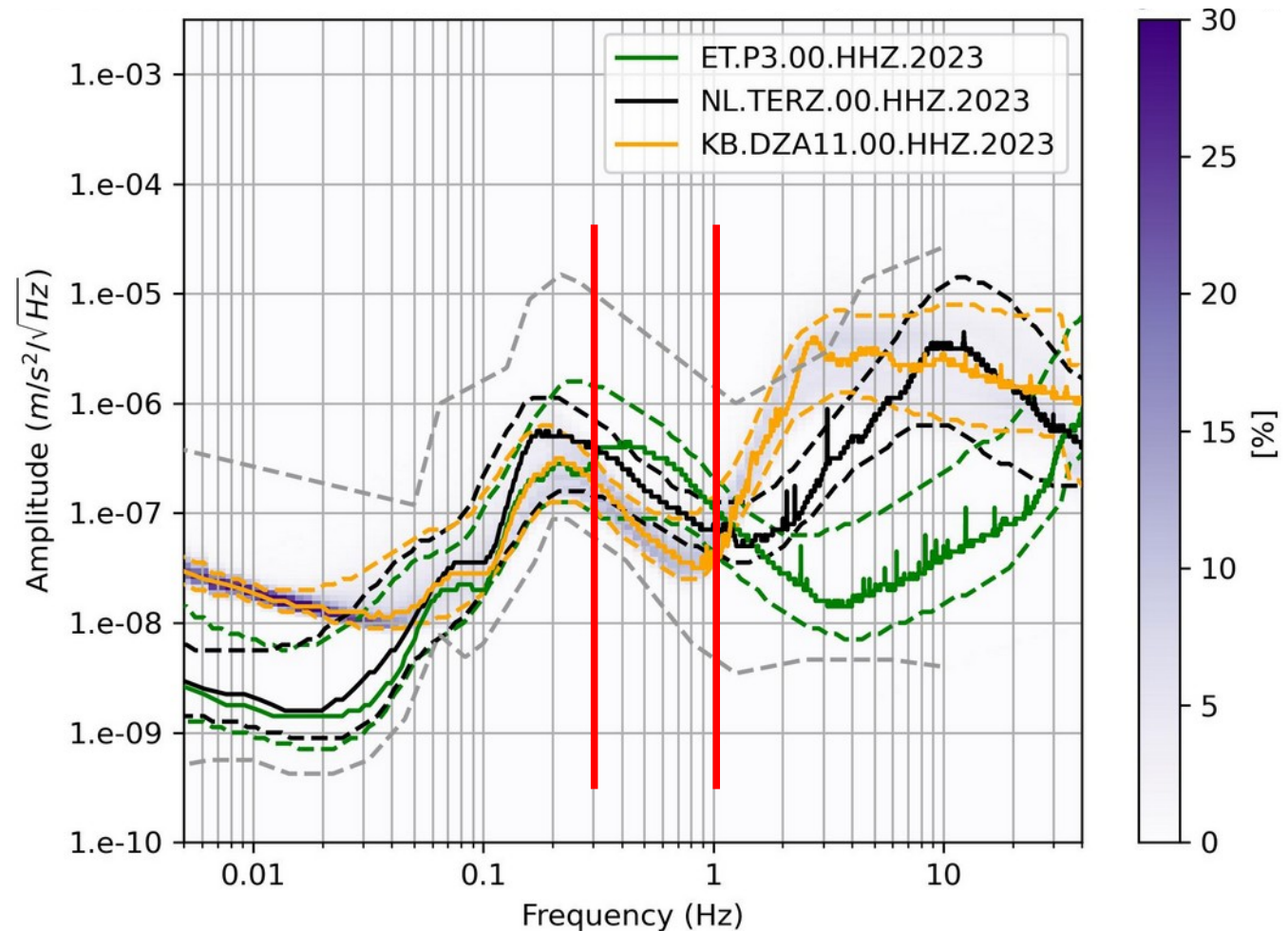
Comparison surface stations 2023

- Lower amplitudes at **Sardinia** P3 for frequencies higher than 2Hz,



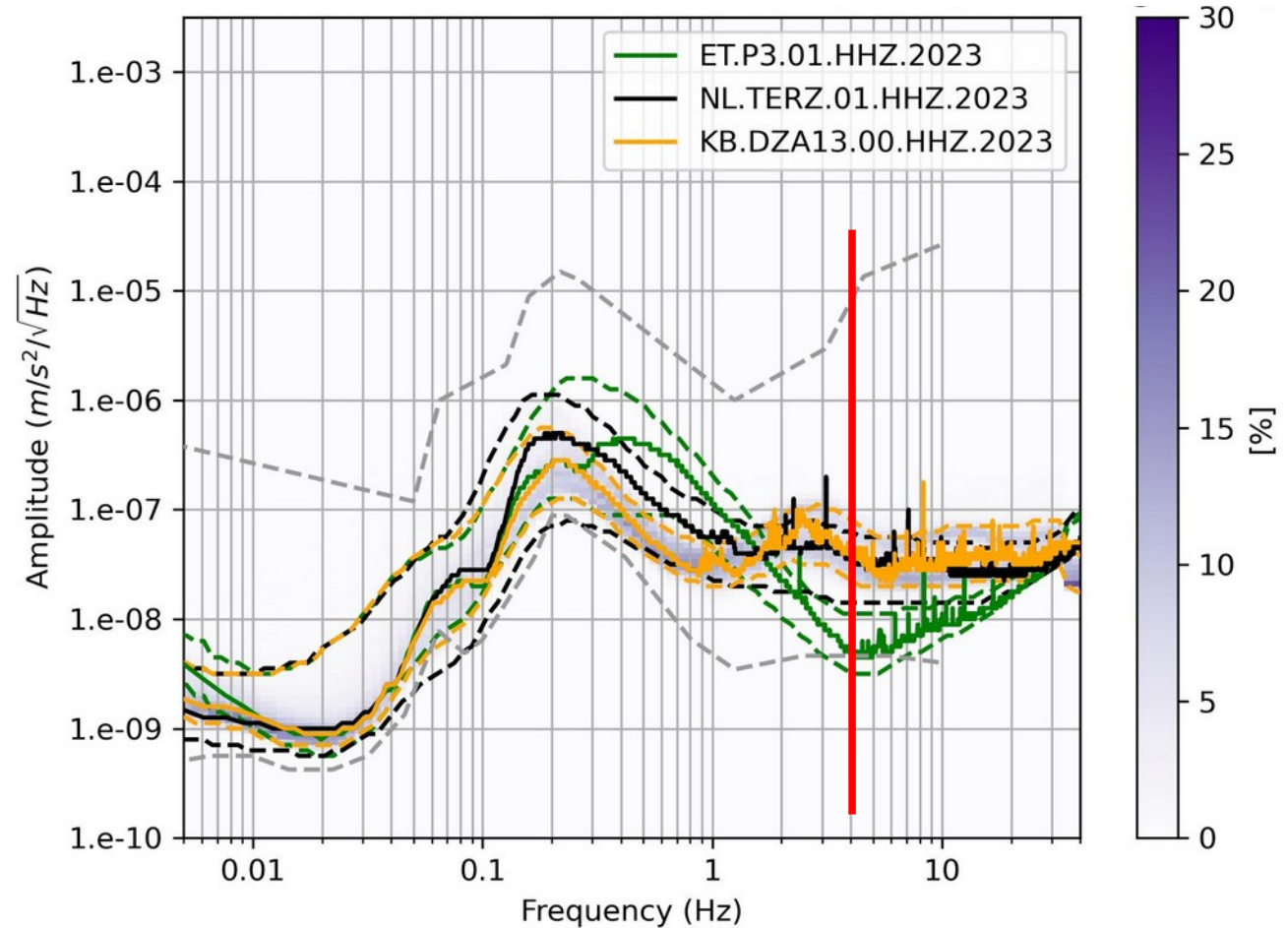
Comparison surface stations 2023

- Lower amplitudes at **Sardinia** P3 for frequencies higher than 2Hz,
- but higher noise levels between 0.3 Hz and 1Hz in comparison to **EMR** and **Lausitz**



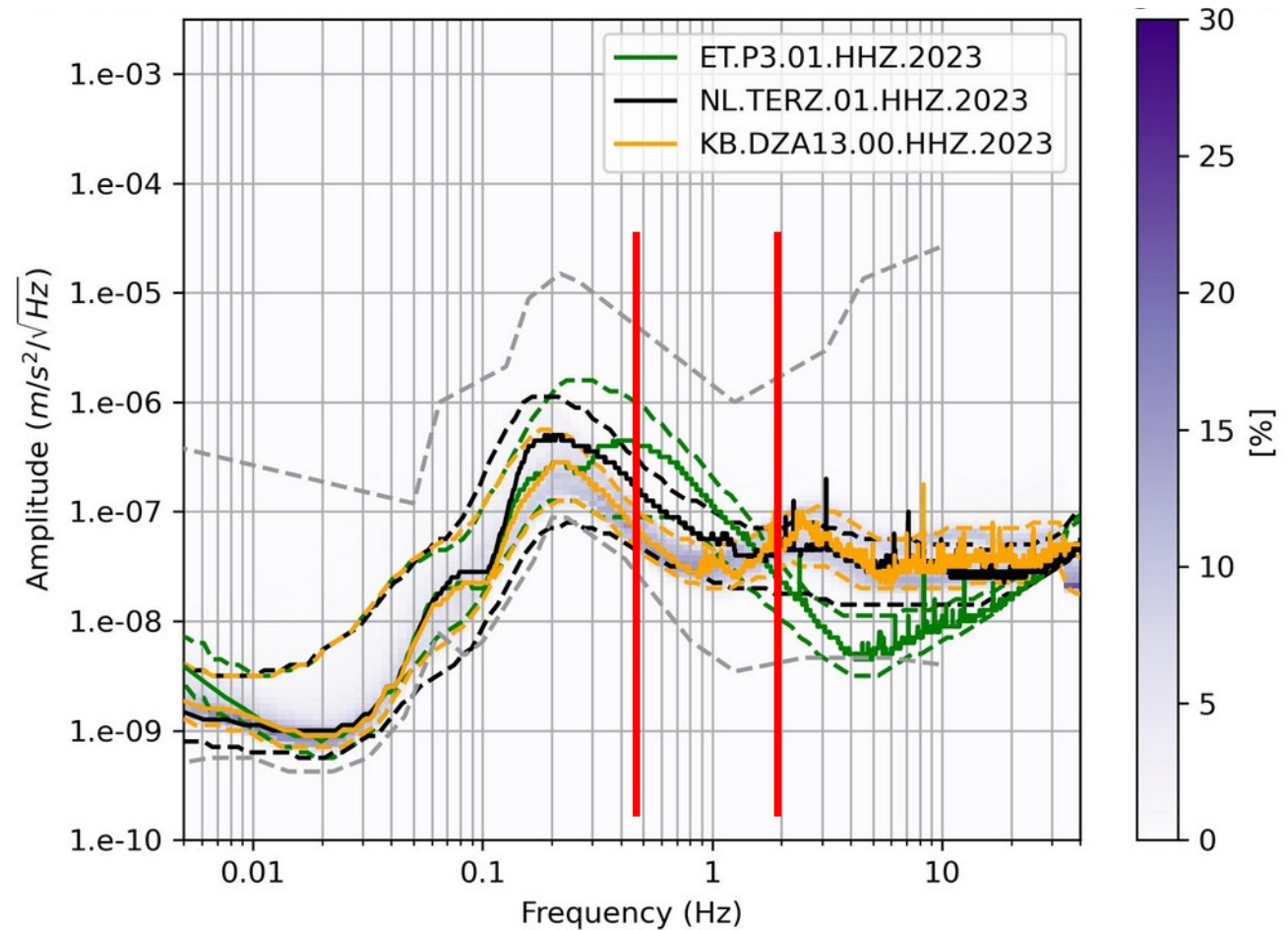
Comparison borehole stations 2023

- **Sardinia** P3 up to a factor of 10 below **EMR** and **Lausitz** around 4 Hz



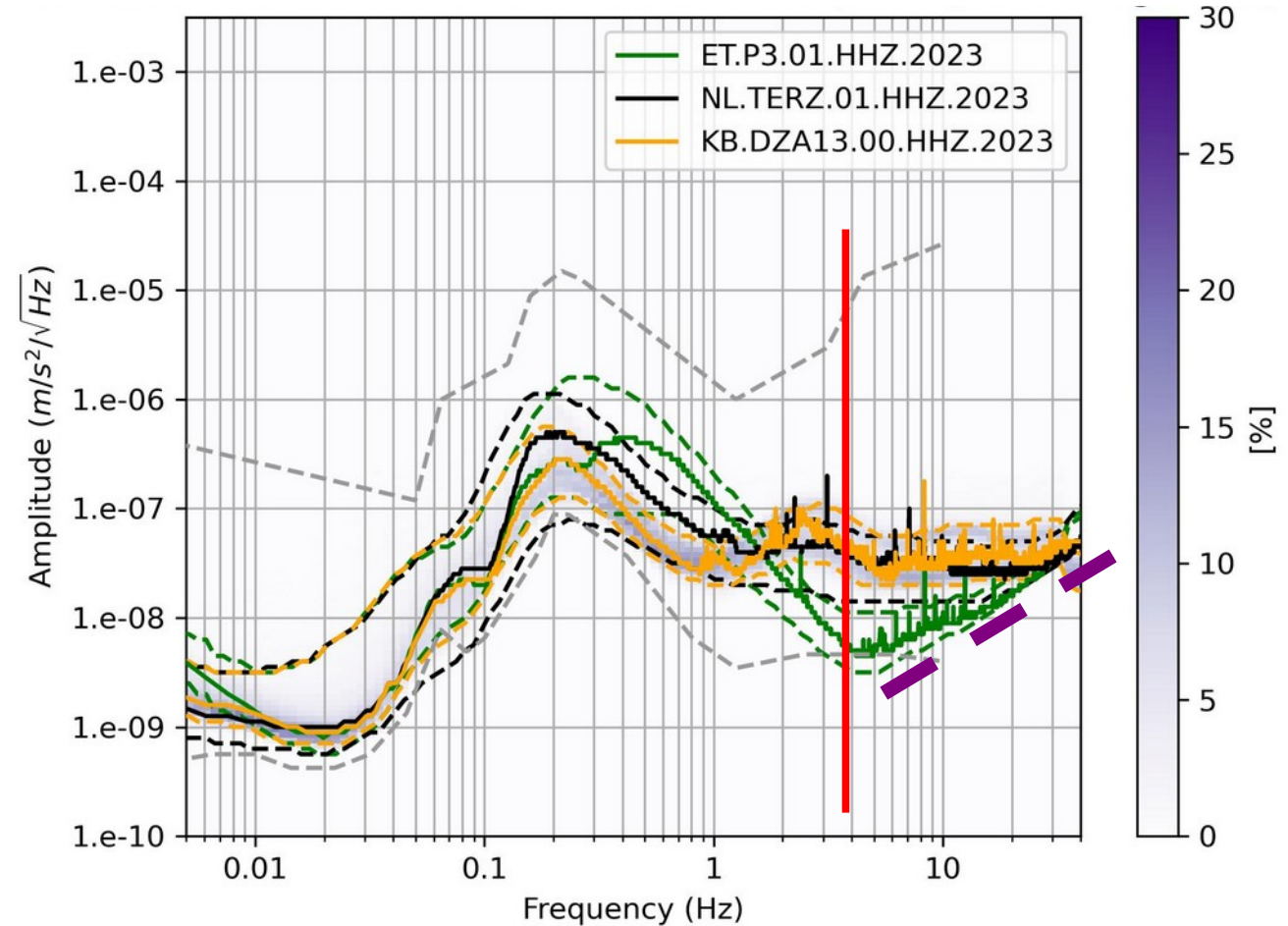
Comparison borehole stations 2023

- **Sardinia** P3 up to a factor of 10 below **EMR** and **Lausitz** around 4 Hz
- **EMR** TERZ and **Sardinia** P3 higher values than **Lausitz** DZA13 from 0.15Hz to 2 Hz



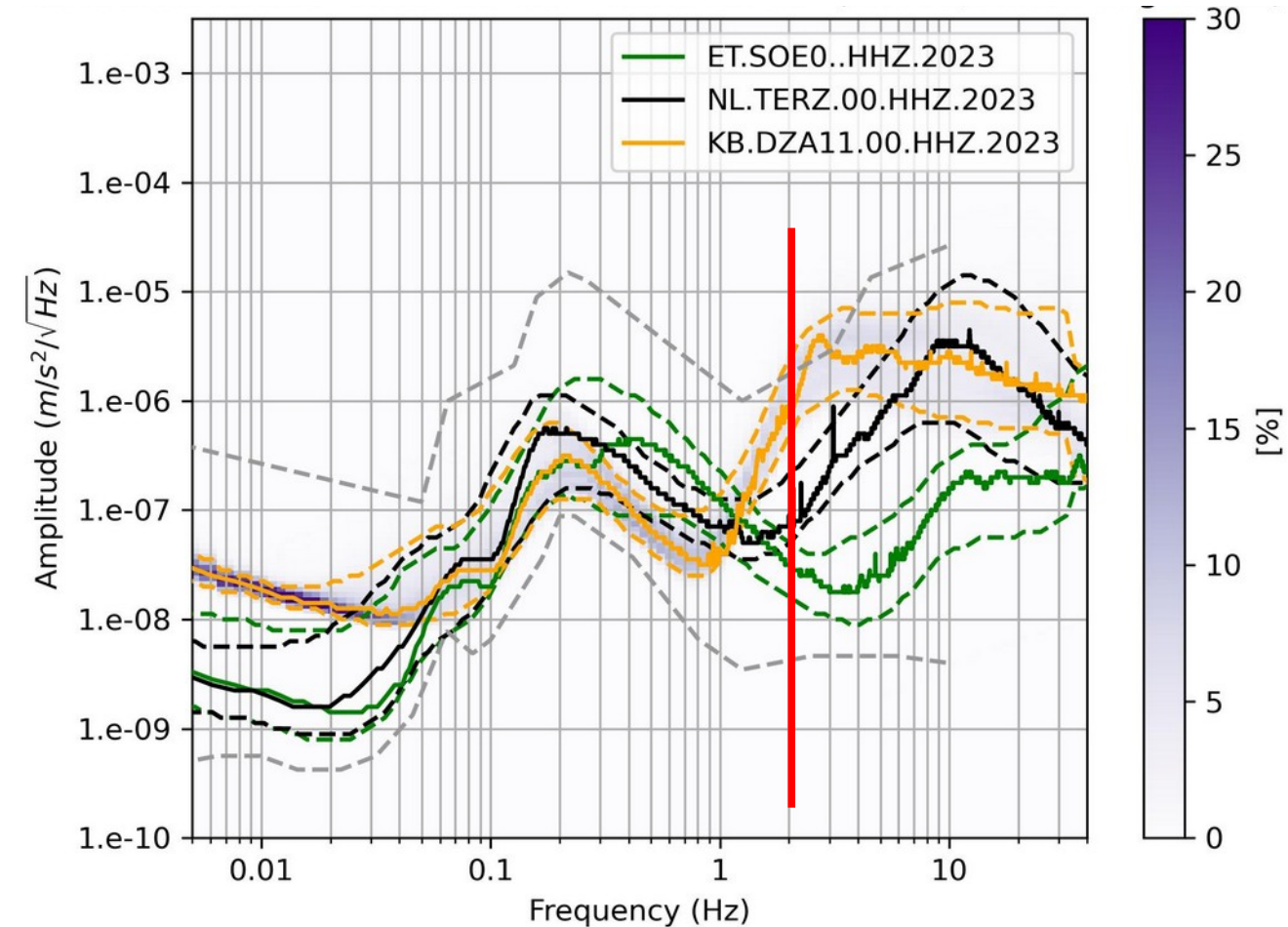
Comparison borehole stations 2023

- **Sardinia P3** up to a factor of 10 below **EMR** and **Lausitz** around 4 Hz
- **EMR TERZ** and **Sardinia P3** higher values than **Lausitz DZA13** from 0.15Hz to 2 Hz
- **Sardinia P3** rise of amplitude for frequencies higher 4 Hz due to **instrumental noise**



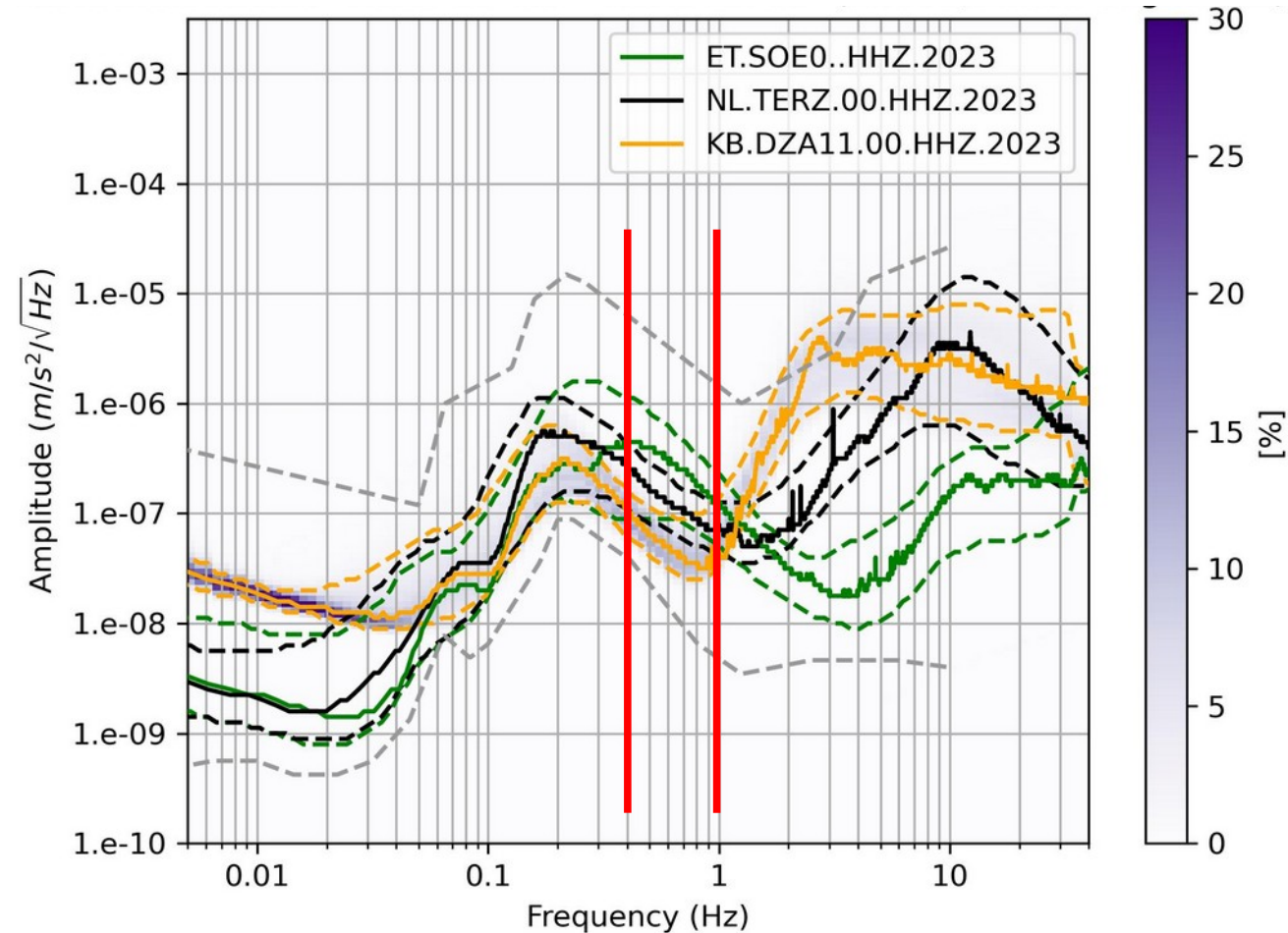
Comparison surface stations with mine 2023

- Clear reduction of amplitudes for **Sardinia** Sos Enattos SOE0 for frequencies higher than 2 Hz,



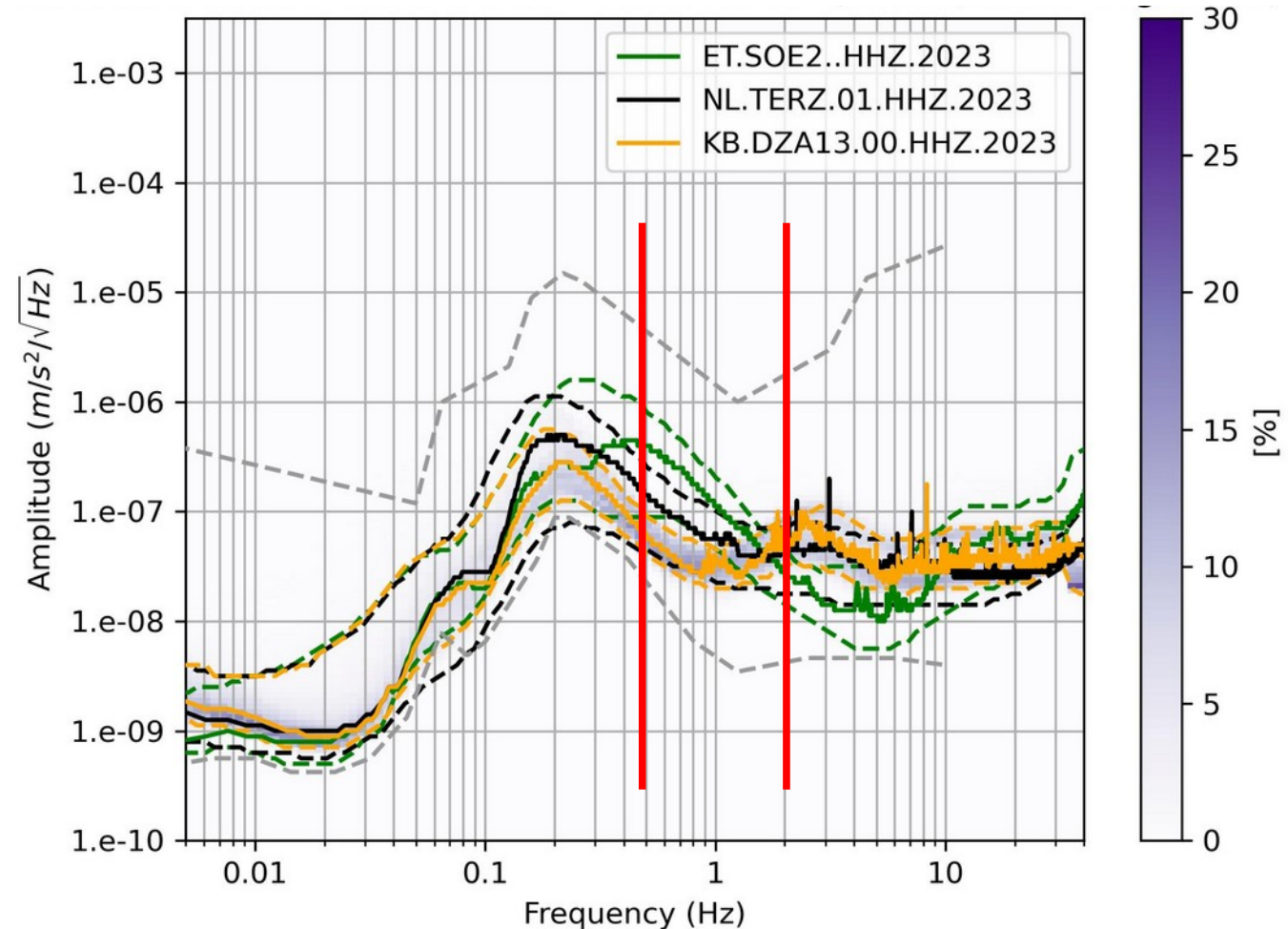
Comparison surface stations with mine 2023

- Clear reduction of amplitudes for **Sardinia** Sos Enattos SOE0 for frequencies higher than 2 Hz,
- but higher noise levels between 0.3 Hz and 1 Hz



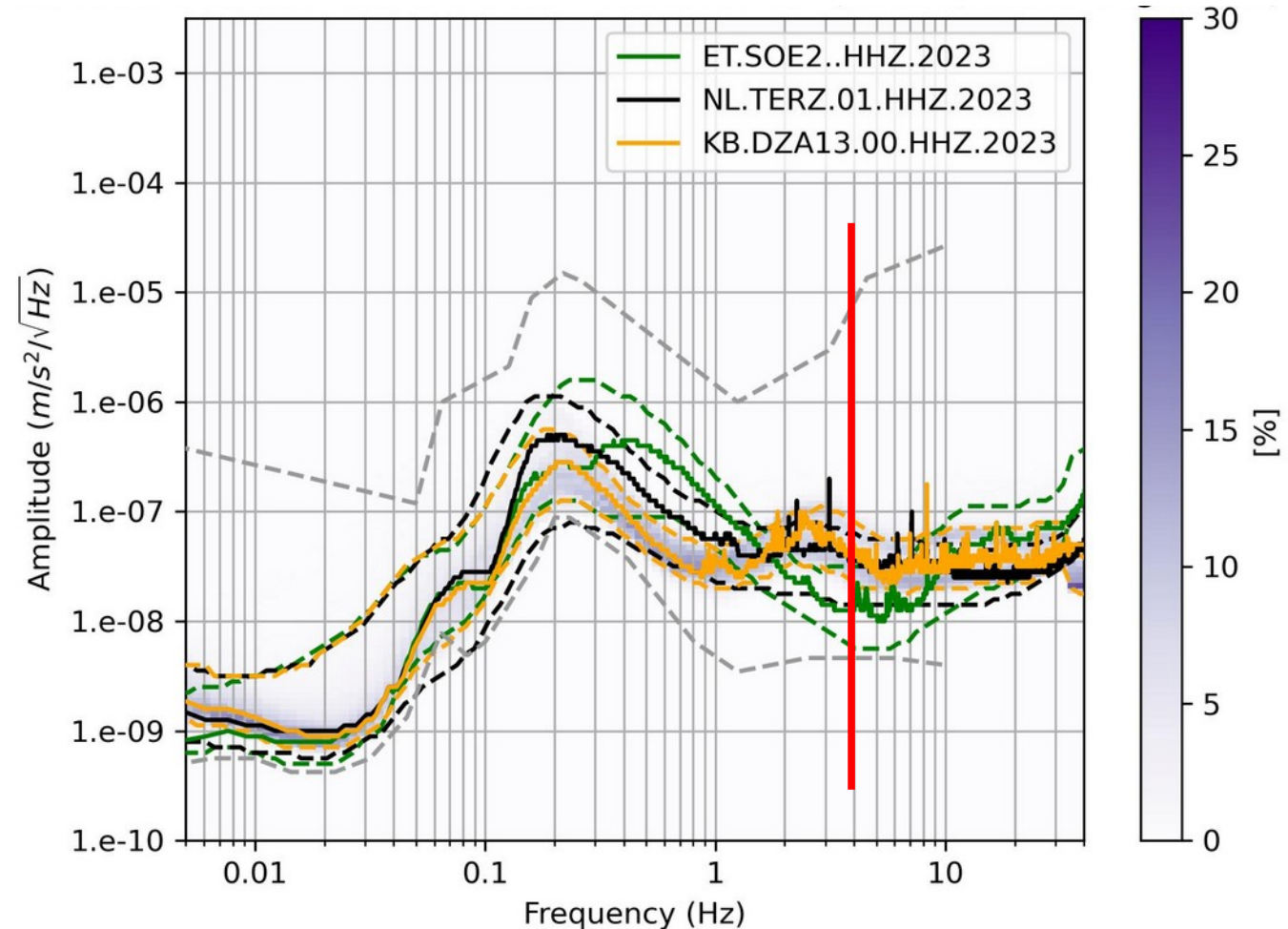
Comparison borehole stations with mine 2023

- **EMR TERZ** and **Sardinia SOE2**
 higher values than **Lausitz**
DZA13 from 0.15 Hz to 2 Hz



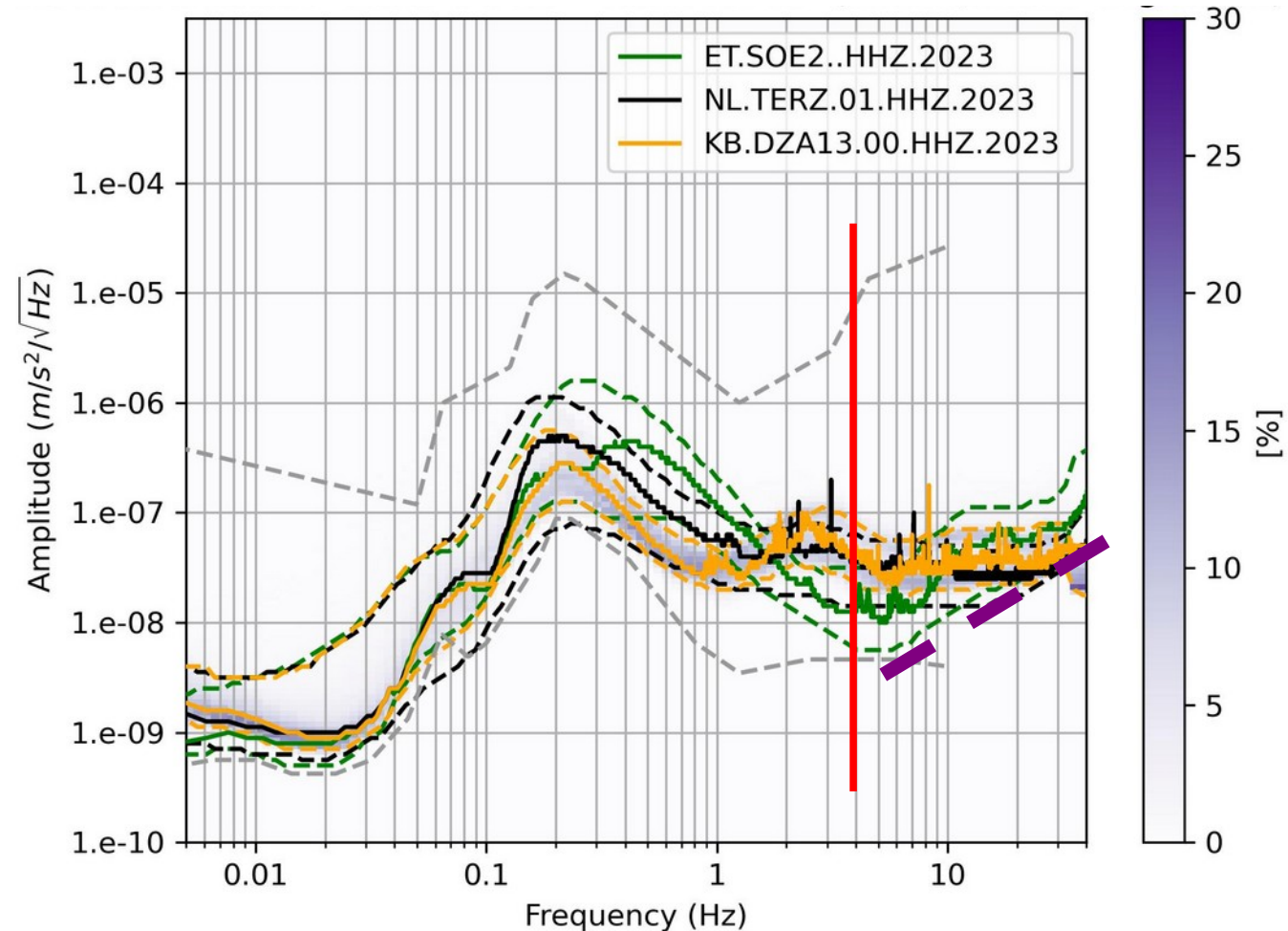
Comparison borehole stations with mine 2023

- **EMR** TERZ and **Sardinia** SOE2 higher values than **Lausitz** DZA13 from 0.15 Hz to 2 Hz
- **Sardinia** SOE2 up to a factor below **EMR** and **Lausitz** around 4 Hz



Comparison borehole stations with mine 2023

- **EMR** TERZ and **Sardinia** SOE2 higher values than **Lausitz** DZA13 from 0.15 Hz to 2 Hz
- **Sardinia** SOE2 up to a factor below **EMR** and **Lausitz** around 4 Hz
- **Sardinia** SOE2 rise of amplitude for frequencies higher 4 Hz due to **instrumental noise**



Outline

- Proposed ET candidate sites in:
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- Comparison of seismic noise observations
- **Conclusions / Outlook**

Conclusions/Outlook

- All candidate sites reach a noise level below $1e-7 \text{ m/s}^2/\sqrt{\text{Hz}}$ on average
- **Sardinia** shows the **lowest noise** values between 2-14Hz and shows a significant increase at lower frequencies
- **EMR** and **Lausitz** show a clear dependence on **cultural noise** (day-night, weekdays-weekends)
- At the underground laboratory at **Sos Enattos** the seismic noise level is increased but still below EMR and Lausitz
- There are distinct frequency peaks in the PSD reaching higher values
- There is a **strong need for full characterisation** of the incoming noise wave field for an evaluation of the sensitivity on the ET telescope