SEISMOLOGY

TCS seismology: Open Seismic Data Everybody seismologist

Koen Van Noten & colleagues in whole Europe

Royal Observatory of Belgium

SEISMOLOGY
GRAVIMETRY

belspo

EPOS-BE
EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

SEISMOLOGY

TCS Seismology

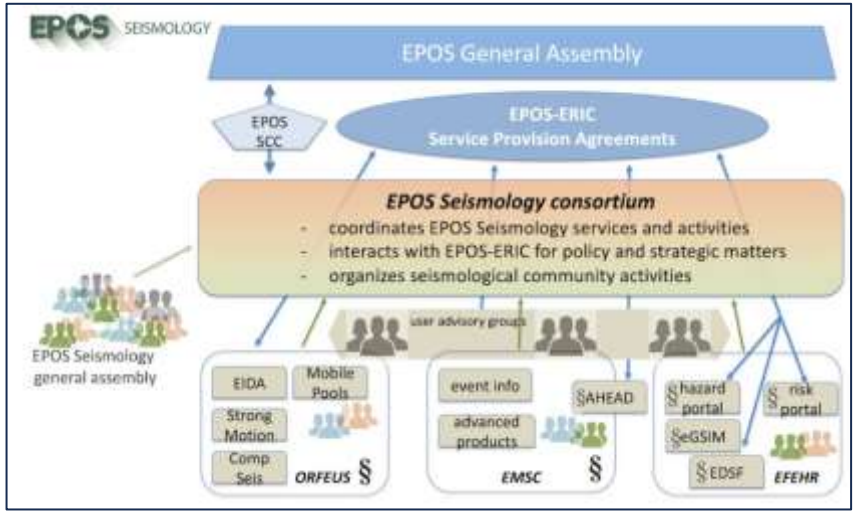
Coordinated by the three main European organisations active in the field, supported by their respective scientific communities:

ORFEUS (Observatories and Research Facilities for European Seismology)

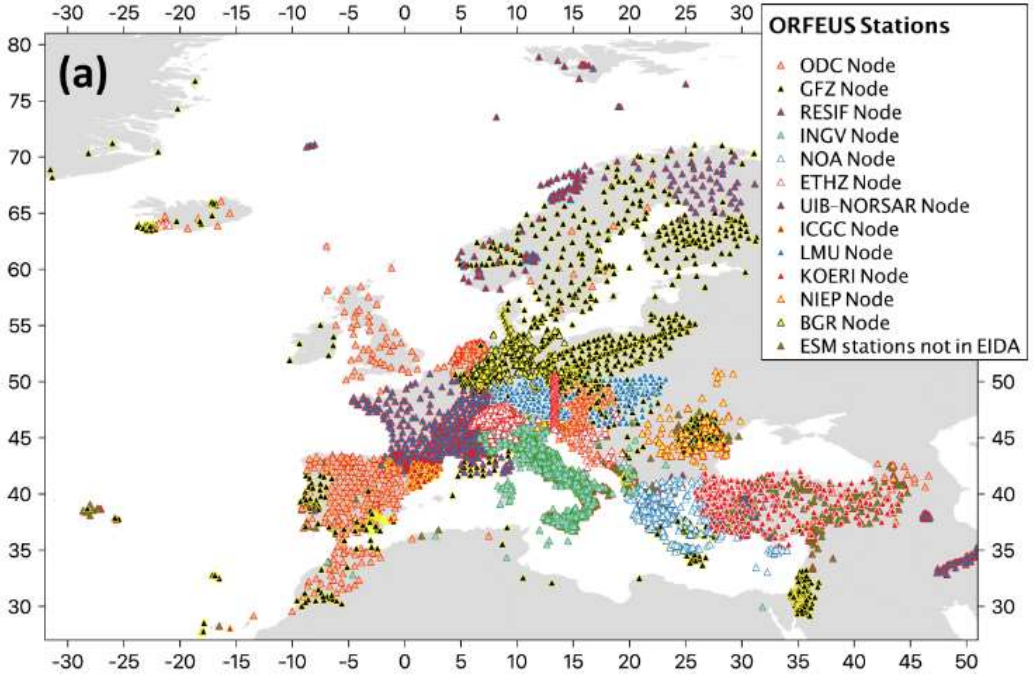
EMSC (Euro-Mediterranean Seismological Center)

EFEHR (European Facilities for Earthquake Hazard and Risk).

The Thematic Core Service (TCS) for Seismology coordinates the provision, within the EPOS infrastructure, of various seismology-related services, such as waveform data, station information, parametric earthquake information products, and seismic hazard & risk data and products in Europe.



Haslinger et al. 2022 EPOS TCS Seismology, Ann. Geophy 65*



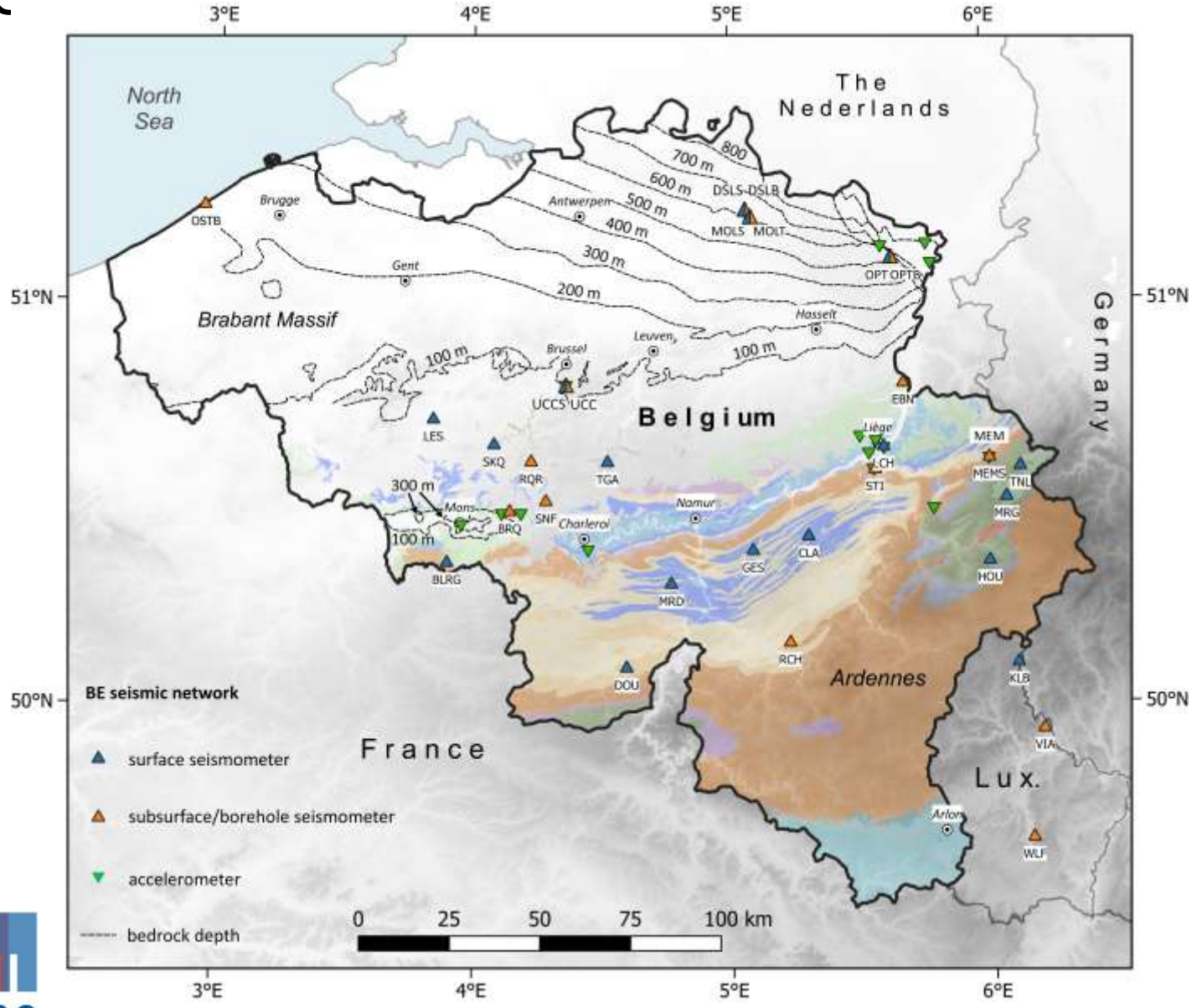
EPOS-BE
EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

SEISMOLOGY

Belgian Seismic network

- UCC - network
- First seismometer in 1899
- Dense network since 1985
- ~30 seismometer sites
- 16 « strong-motion » accelerometer sites

- Site renewal thanks to
  - BELSPO EPOS-BE project
  - Continuous ROB investments



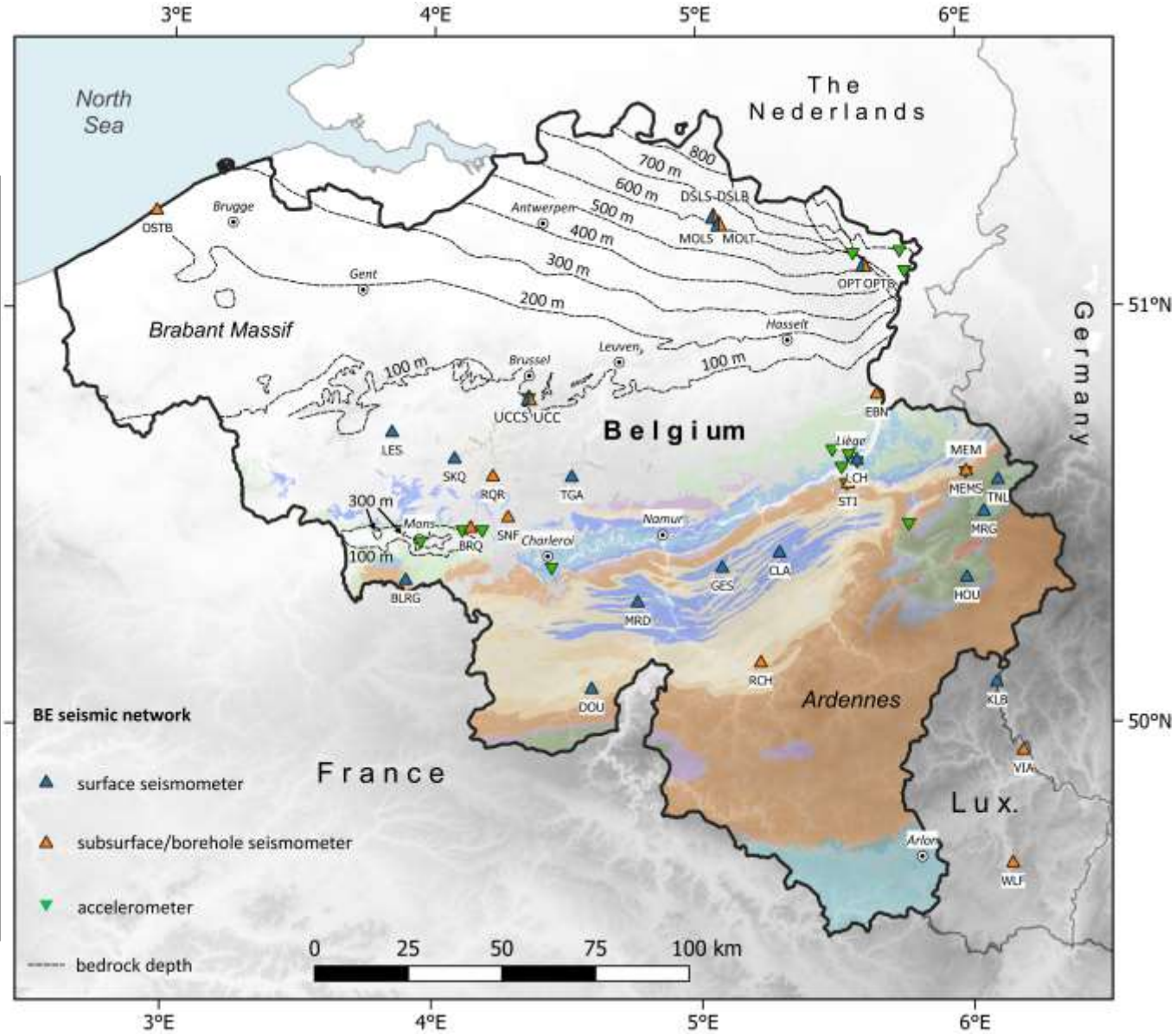
EPOS-BE EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

belspo

Belgian Seismic network

SEISMOLOGY

Code	Site	Renewal date	EPOS.BE Funded instruments (~111 k€)
DOU	Dourbes	17.06.2021	Nanometrics Centaur datalogger
GES	Gesves	01.07.2021	Nanometrics Trillium Compact Posthole
SNF	Seneffe	05.08.2021	Nanometrics Trillium Compact Posthole + Nanometrics Centaur datalogger
CLA	Clavier	13.08.2021	Nanometrics Trillium Compact Posthole
MEM	Membach	09.09.2021	Nanometrics Centaur datalogger
LCH	La Chartreuse (Liège)	24.02.2022	Nanometrics Trillium Compact Posthole + Nanometrics Centaur datalogger
BOU →BLRG	Bougnies → Blaregnies	07.09.2022/23.11.2022	Nanometrics Trillium Compact Posthole + Nanometrics Centaur datalogger
SKQ	Steenkerque	10.05.2023	Nanometrics Trillium Compact Posthole + Nanometrics Centaur datalogger
RQR	Ronquières	23.05.2023	Nanometrics Centaur datalogger
BRQ	Bracquegnies	14.06.2023	Nanometrics Centaur datalogger



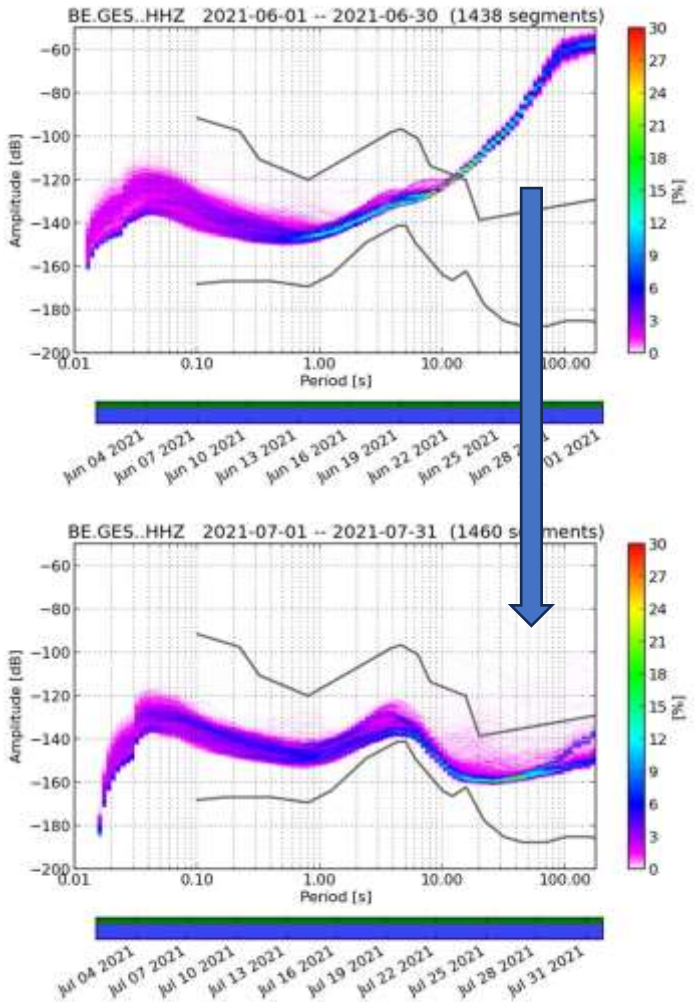
EPOS-BE EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

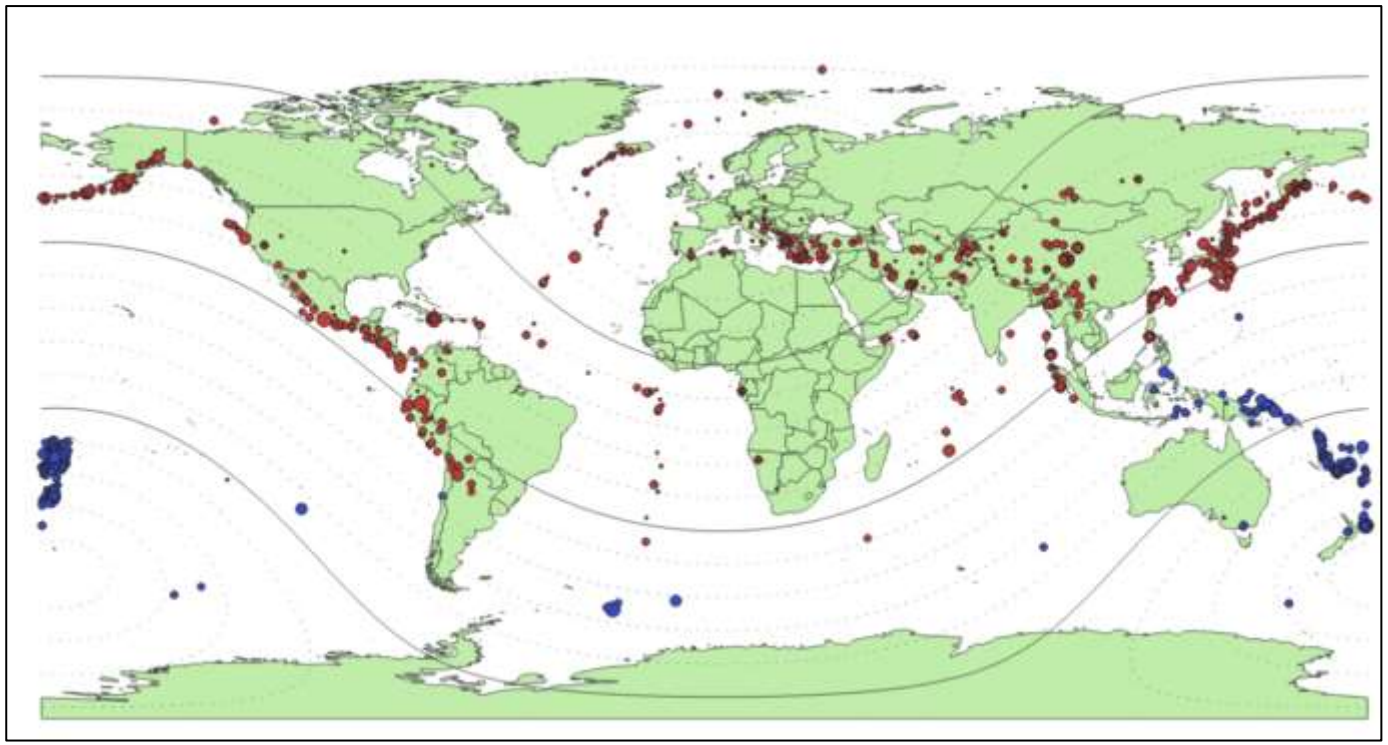
belspo

SEISMOLOGY

Station renewal -> Broadband seismometers

Trillium Compact PH





Teleseismic data
measured with BE stations
available at EMSC

Belgian Stations :
9970 phases,
4234 amplitudes
For 1455 events

EPOS-B BELGIUM
EUROPEANPLATEOBSERVINGSYSTEM

SEISMOLOGY

ALL BE Seismic data at Orfeus - ODC

NEW SINCE 11.2023 !

European Integrated Data Archive EIDA

EIDA, an initative within ORFEUS, is a distributed federation of datacenters established to securely archive seismic waveform data and metadata gathered by European research infrastructures, and provide transparent access to data for the geosciences research communities. EIDA's **organization and management** is handled by the EIDA Management Board. The **EIDA nodes** are data centres that collect and archive data from seismic networks deploying broad-band sensors, short period sensors, accelerometers, infrasound sensors, and other geophysical instruments.

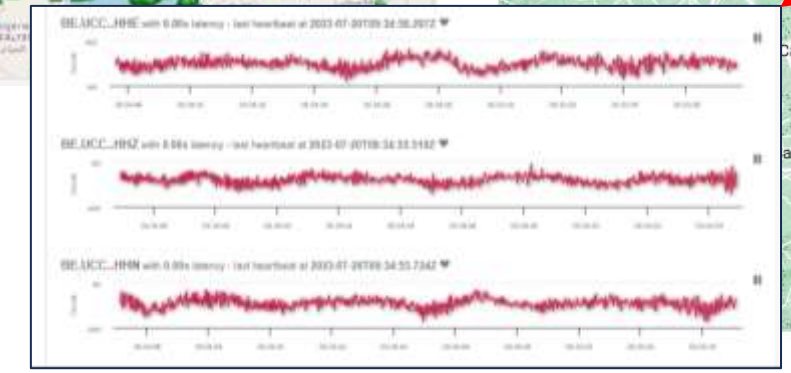
Seismic networks that participate in EIDA are listed as **contributing networks**.

Webinterface
Graphical interface for waveform and metadata access.

Webservices
APIs for data and metadata access.

Data Quality
Interfaces for data quality visualization.

Station Book
Access to the entire EIDA station inventory.



Stations in this Network

https://www.orfeus-eu.org/data/odc/realtime/

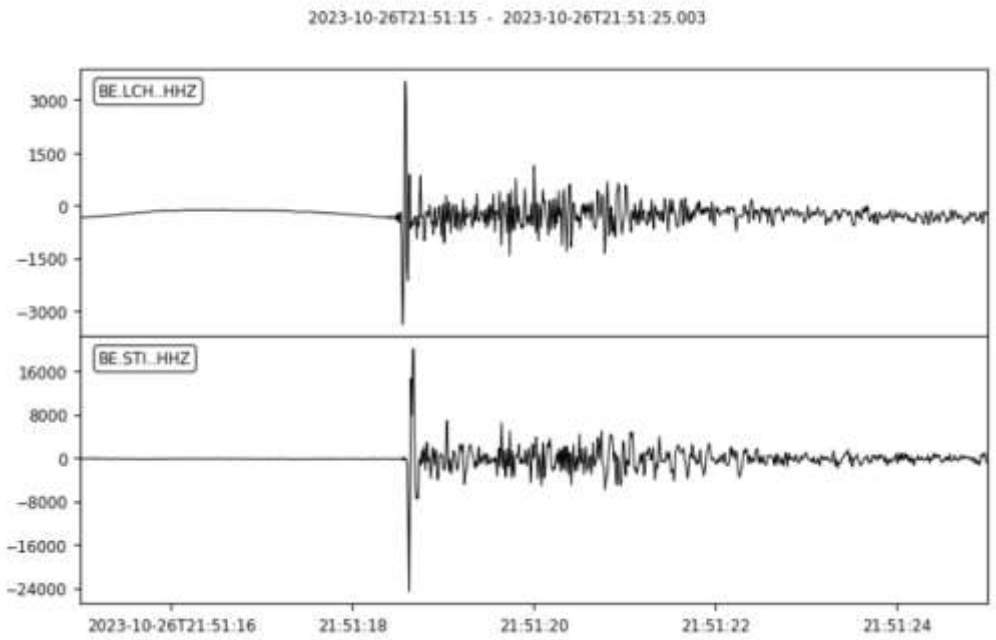
EPOS-BE
EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

ALL BE Seismic data at Orfeus - ODC

SEISMOLOGY

ObsPy
A Python Framework for Seismology

```
import obspy
from obspy.clients.fdsn import Client
client = Client("ODC")
from obspy import UTCDateTime, Stream
t = UTCDateTime("2023-10-26 21:51:15")
st = Stream()
st += client.get_waveforms("BE", "LCH", "*","HHZ", t, t+10)
st += client.get_waveforms("BE", "STI", "*","HHZ", t, t+10)
st.plot(linewidth = 0.75, equal_scale = False)
```



Earthquakes in Belgium

https://seismologie.be/en

ANGLEUR (BE) - 2023-10-26 21:51:15 - MAGNITUDE 1.3
LAST UPDATE : 2023-10-27 00:54:38 BELGIAN TIME

Main parameters

Date and time	2023-10-26 21:51:15 UTC 2023-10-26 23:51:15 Belgian time
Type	Earthquake
Magnitude	M_L 1.3
Region	ANGLEUR (BE)
Epicentral coordinates	50.609° N, 5.608° E Uncertainty ± 0.4 km
Depth of hypocenter	16.5 ± 0.4 km

Data source : ROB (Royal Observatory of Belgium)

Location map

Quake measurements

MEASUREMENTS BY THE BELGIAN SEISMIC NETWORK

Station		Epicentral distance (km)	P-Wave arrival (hh:mm:ss.ss)	S-Wave arrival (hh:mm:ss.ss)	Maximal ground displacement (nm)
Code	Place				
LCHA	LA CHARTREUSE	3	21:51:18.52	21:51:20.50	164.3
LCH	LA CHARTREUSE	3	21:51:18.53	21:51:20.51	31.6

EPOS-BE
EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

SEISMOLOGY

Site characteristics – know your station!

- Subsurface structure below each seismic station
- Geophysical work
- Site amplification ?

UCC(A/B) – Uccle

Geology

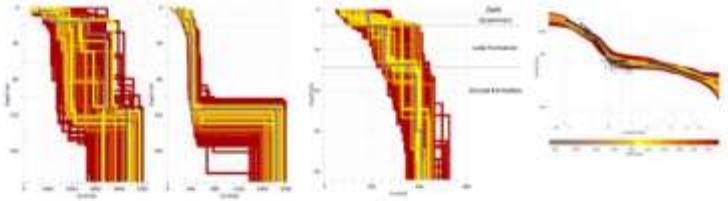
Fieldwork

Geology & lithology:

- 114 m soft sediment geology above Brabant Massif. Top: Lede Formation
- Tubize Formation as bedrock

Array information:

- Regular cross installation
- One month or array installation
- First EPOS-BE array installation



Site characterization results

- input: fk dispersion curve, rayleigh wave ellipticity
- inversion of 4 layers with prior borehole knowledge (soft soil over bedrock)
- V_{s30} derived from soft sediment/bedrock velocity profile, Vp soft sediment profile less resolved

Orfeus Stationbook parameters	
Geological Unit	Sand (UCC): Lede Fm and sand/quartzite (UCCB: Tubize Fm)
Morphology Class	T1
Ground Type EC8	B
Groundwater Depth (m)	unknown
v_{s30} [m/s]	280 (UCC) - 1800 (UCCB)
f_0 [Hz]	0.9
Amp(f_0)	14
Basin Flag	True
Bedrock Depth (m)	115
Description	

Summary:

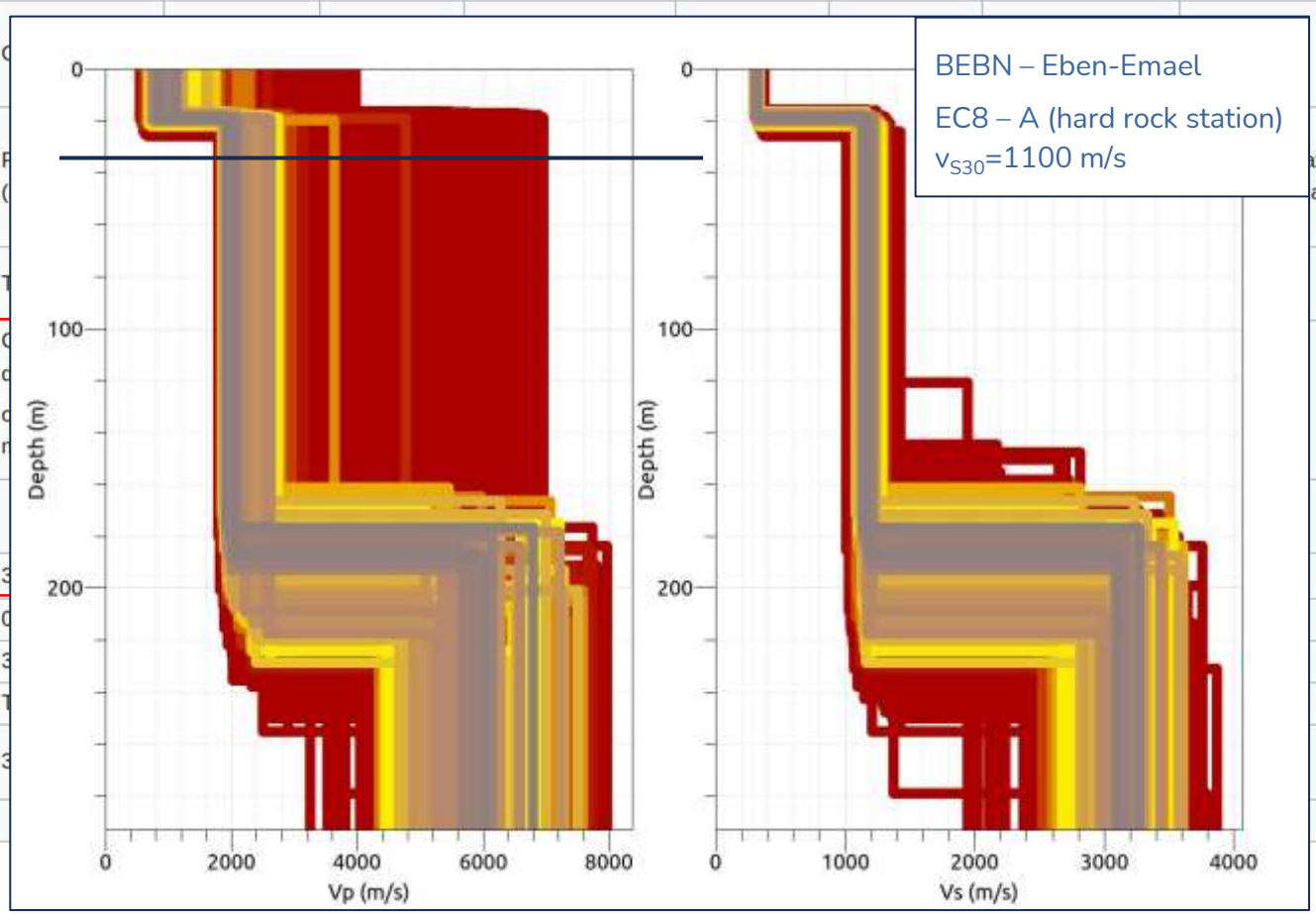
UCC is a soft sediment surface station with a low V_{s30} (280 m/s). Vs of the Brussels sands predominate the Vs in the first 115 m

UCCB is the borehole station placed in the Tubize Formation of the Brabant Massif with a fast bedrock velocity (V_{s30} = 1800 m/s).

SEISMOLOGY

Site characteristics – know your station!

Orfeus Stationbook parameters	CLA	EBN	GES
Geological Unit	Limestone (Longpré formation)	Chalk (Upper Cretaceous, Maastrichtian)	Sandstone (Famennian, Ciney formation)
Morphology Class	T2	n/a	T1
Ground Type EC8	A (hard rock)	A (hard rock)	A (hard rock)
Groundwater Depth [m]	25 - 30	~ 20	~ 10
$v_{S_{30}}$ [m/s]	2900	1100	982 +/- 32
f_0 [Hz]	n/a	n/a	~ 50
Amp(f_0)	n/a	n/a	10
Basin Flag	False	False	False
Bedrock Depth [m]	0	0	0.3
Description			



EPOS-BE EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

SEISMOLOGY

Site characteristics of whole BE network

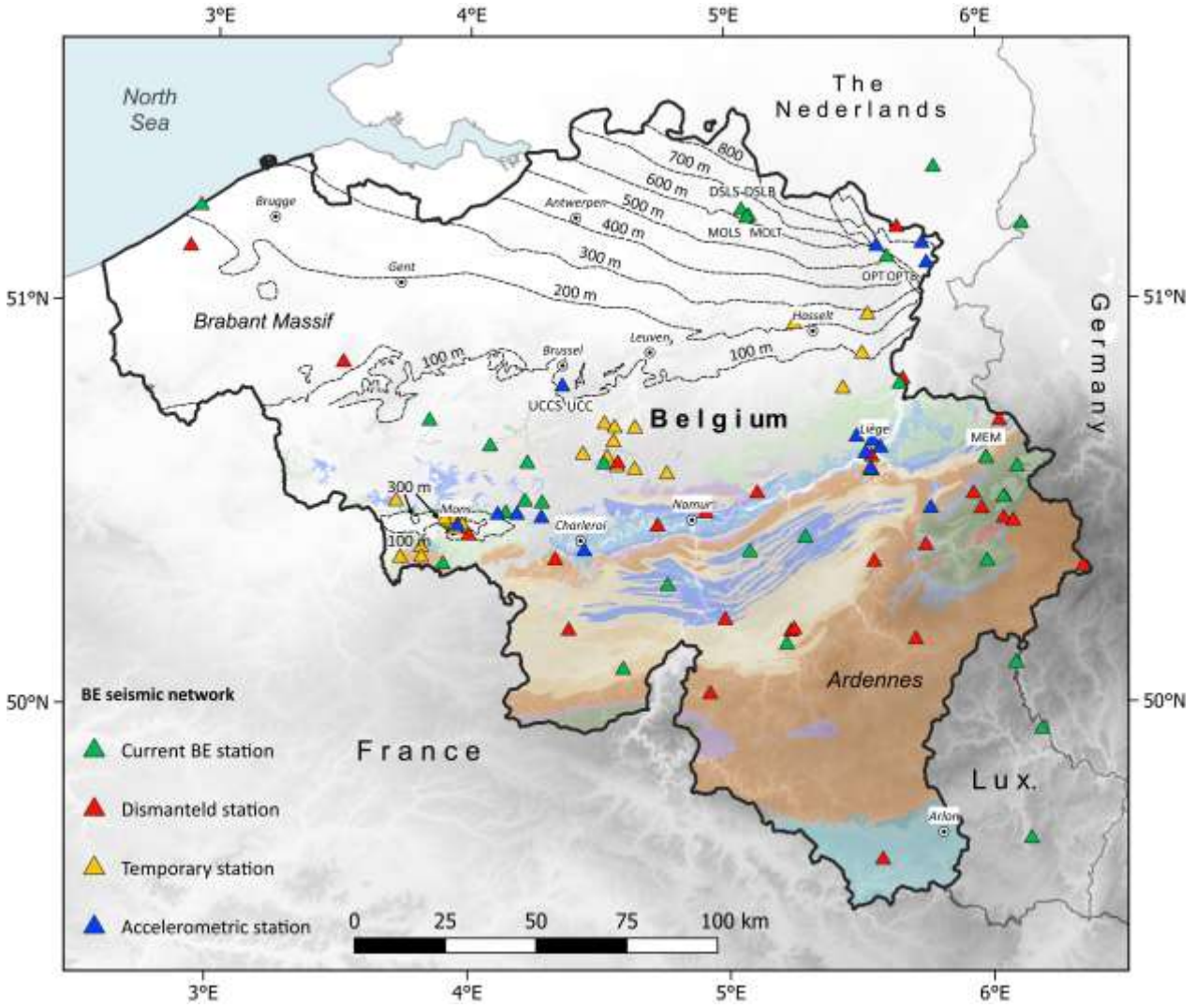
RESULTS

EPOS-BE knowledge transfer to site characterisation of

- Current network (45)
- Dismantled stations (29)
- Temporary networks (34)
- Accelerometric network (16)

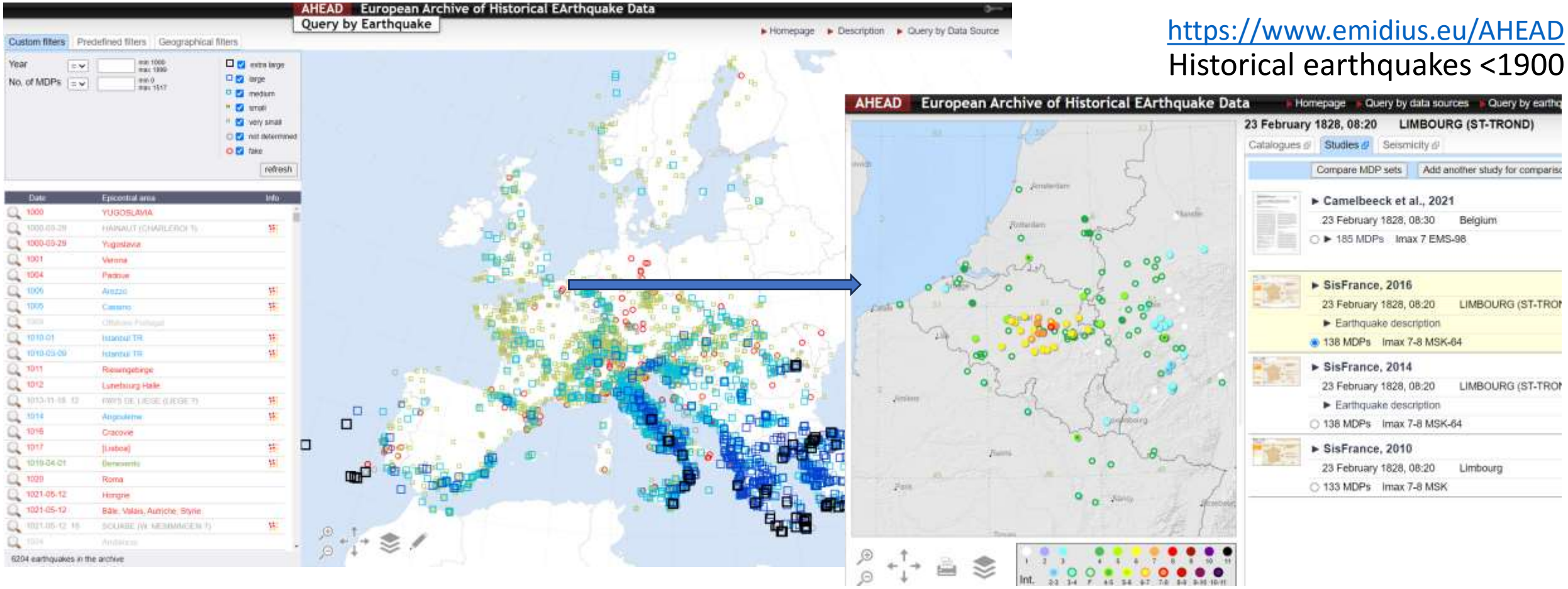
USEFUL FOR

-> example for industrial networks
-> future stations



EPOS-BE
EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

AHEAD database



https://www.emidius.eu/AHEAD
Historical earthquakes <1900

EPOS-BE
EUROPEANPLATEOBSERVINGSYSTEM BELGIUM

SEISMOLOGY

Open Seismic Data
Everybody seismologist

EPOS-BE Site characterization at Eben-Emael

Thank you for the attention

Merci

Bedankt

Dankeschön

EPOS-BE
EUROPEANPLATEOBSERVINGSYSTEM BELGIUM