

SITE CANDIDATES FOR THE EINSTEIN TELESCOPE

DAVID RABELING

24/03/2010

COMBINED WQ1 - TWT MEETING @ NIKHEF AMSTERDAM

SITE CHARACTERISATION AND CLASSIFICATION

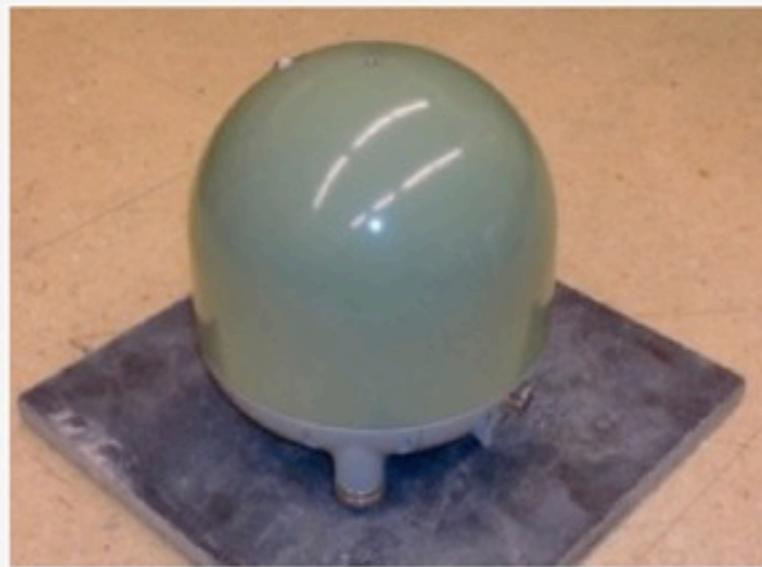
- SEISMIC < 1HZ (AMBIENT BACKGROUND)
- SEISMIC > 1HZ (ANTHROPOGENIC NOISE)
- DIURNAL STABILITY
- EXISTING INFRASTRUCTURE
- REMOTENESS
-

ENVIRONMENTAL MEASUREMENT DEVICES

□ TWO/THREE TRILLIUM T240



The seismometers are usually mounted on a hardrock tile (attached to the ground with concrete) and covered by an acoustic insulating cover. A thermal insulating box filled with insulation foam is then placed on top of the instrument to further isolate the instrument from external influences.

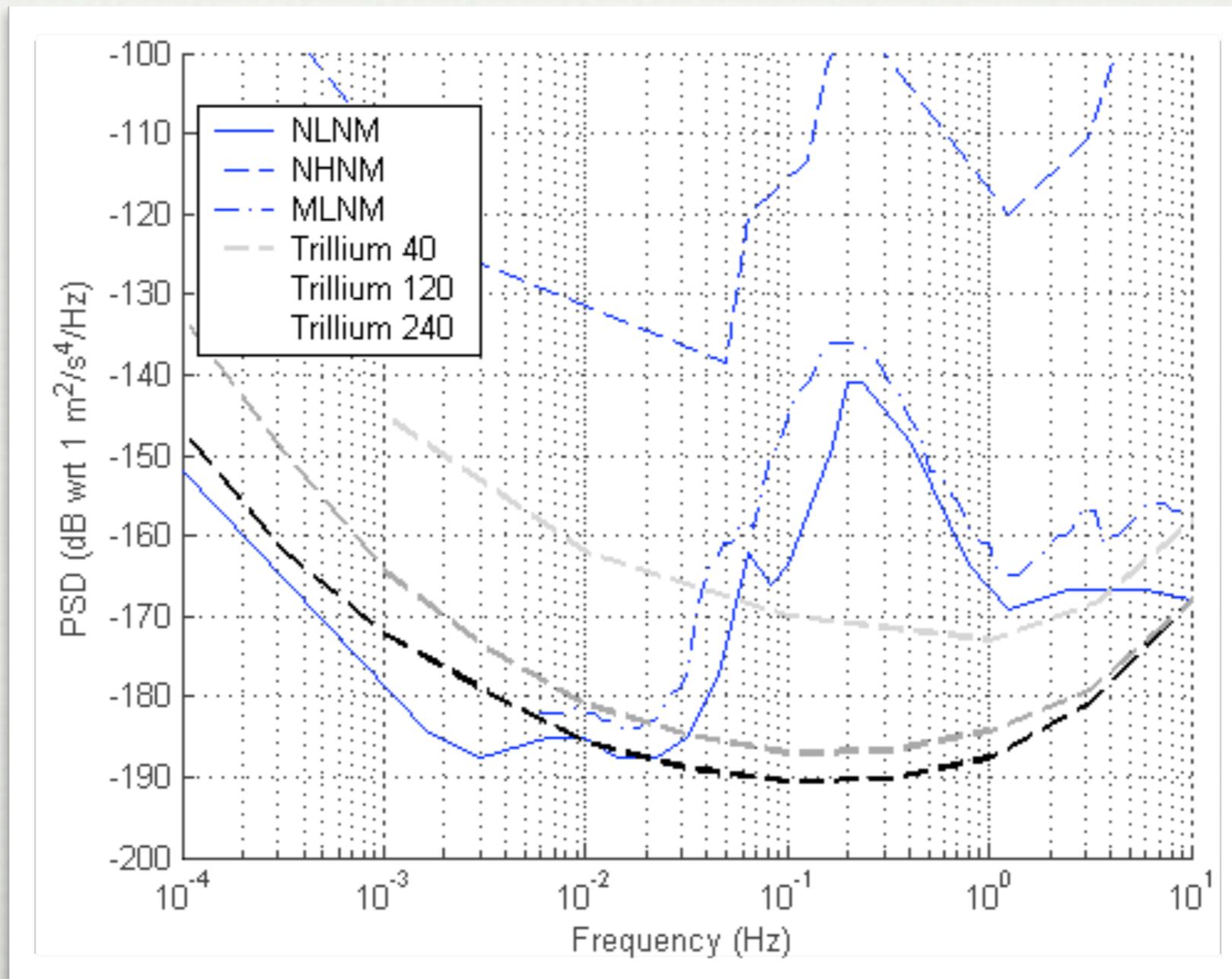


Specification		
Type	Nanometrics Trillium T240	
Diameter	25	cm
Height	28.6	cm
Weight	14	kg
Bandwidth	-3dB at 244 s & 223 Hz	
Operating Temperature	-20 - 50	Deg. C

For more details please see the [nanometrics site](#).

ENVIRONMENTAL MEASUREMENT DEVICES

□ TWO/THREE TRILLIUM T240



ENVIRONMENTAL MEASUREMENT DEVICES

□ LABVIEW MEASUREMENT INTERFACE (SIMILAR TO HOMESTAKE)



Seismic data acquisition is done using a National Instruments DAQmx card (PCI 6289) in a PC mounted into a 19 inch portable flight case. LabView is used to create control, monitor and acquisition software specific to the seismometer. The seismometer signals are amplified and filtered by an external amplifier before being read by the DAQ. Sampling is done at 128 Hz. The least significant bit input voltage of ~ 80 nV results in a seismic noise sensitivity of $\sim 6.5e-11$ m/s. Below the low noise model from DC - 20 Hz.



Data acquisition unit with seismometer in acoustic cover

Specification		
DAQ card	National Instruments PCI 6289 18 bits	
Software	Windows, LabView	
Amplifier	Own design, low noise, 100 x, Low pass 25 Hz	
UPS	APC SUA1500 (Uninterrupted power supply) Max. back-up time ~ 45 mins	
Flight case	SKB R908U20	
Height	58	cm
Weight	76	cm
Depth	73	cm
Total weight	70	kg

ENVIRONMENTAL MEASUREMENT DEVICES

- ENVIRONMENTAL TEMP./HUM. DATA LOGGERS
(NO LABVIEW DATA ACQUISITION AVAILABLE)



LESSONS FROM HOMESTAKE

- ☑ ENVIRONMENTAL SHIELDING.



LESSONS FROM HOMESTAKE

☑ ENVIRONMENTAL SHIELDING.

☑ DAQ PROCEDURES.



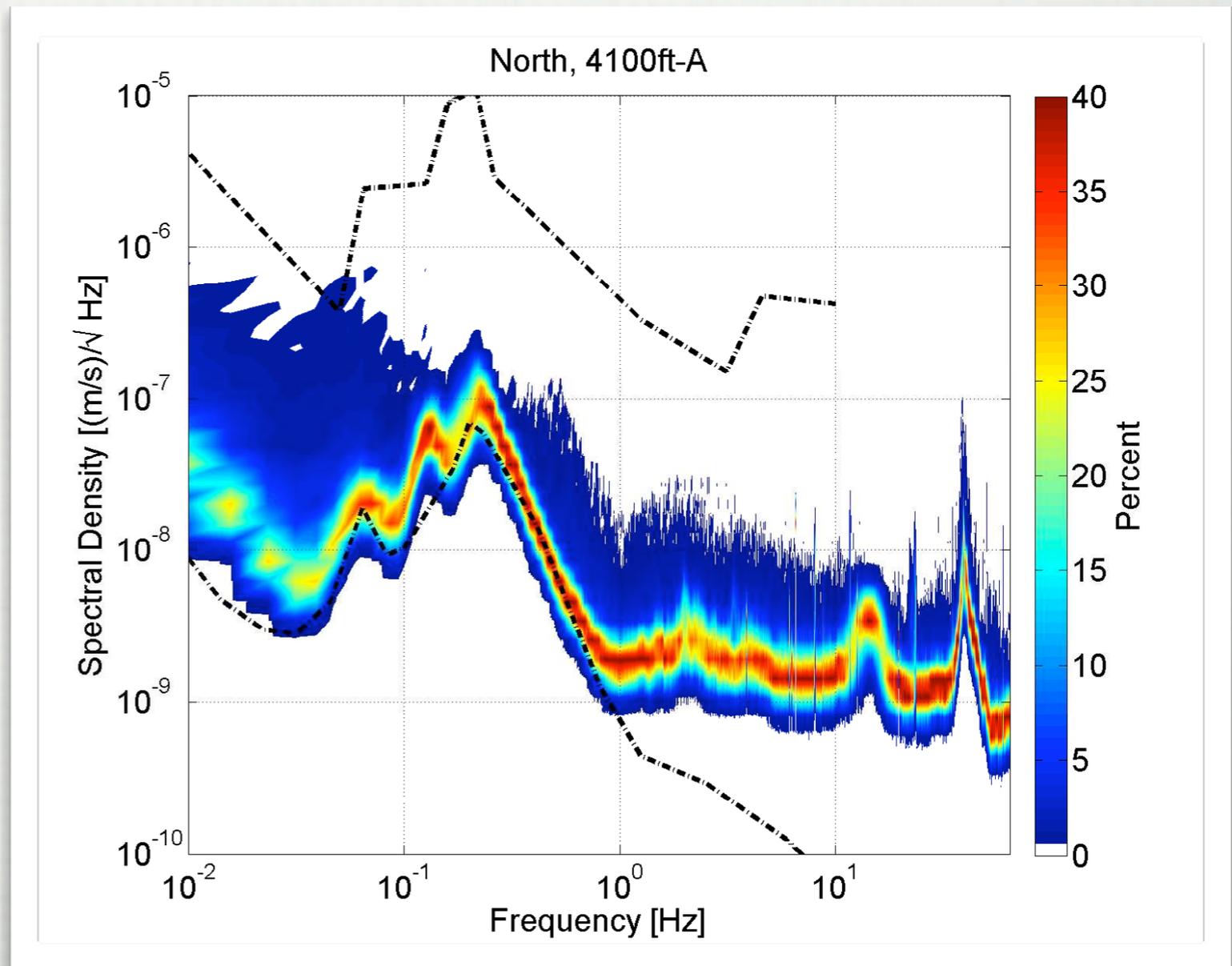
LESSONS FROM HOMESTAKE

- ☑ ENVIRONMENTAL SHIELDING.
- ☑ DAQ PROCEDURES.
- ☑ STATION SET-UP.



LESSONS FROM HOMESTAKE

- ✓ ENVIRONMENTAL SHIELDING.
- ✓ DAQ PROCEDURES.
- ✓ STATION SET-UP.
- ✓ DATA PROCESSING TECHNIQUES.



OVERVIEW OF MEASUREMENT SITES

ITALY:
GRAN SASSO

USA:
HOMESTAKE

ITALY:
SICILY

NETHERLANDS: HEIMANSGROEVE

HUNGARY:
GYÖNGYÖSOROSZI MINE

ROMANIA:
SLANIC-PRAHOVA

FRANCE:
FREJUS

SPAIN:
CANFRANC

JAPAN:
KAMIOKA

ITALY:
SARDINIA

POLAND:
POLKOWICE-SIEROZOSWICE

GERMANY:
BLACK FOREST

GERMANY:
ASSEN SALT MINE

GERMANY:
HARZ MOUNTAINS

FINLAND:
PYHARJAVI

UK:
BOUBLY

OVERVIEW OF CANDIDATE SITES

ITALY:
GRAN SASSO

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HOMESTAKE

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MEASUREMENT OVERVIEW

ITALY:
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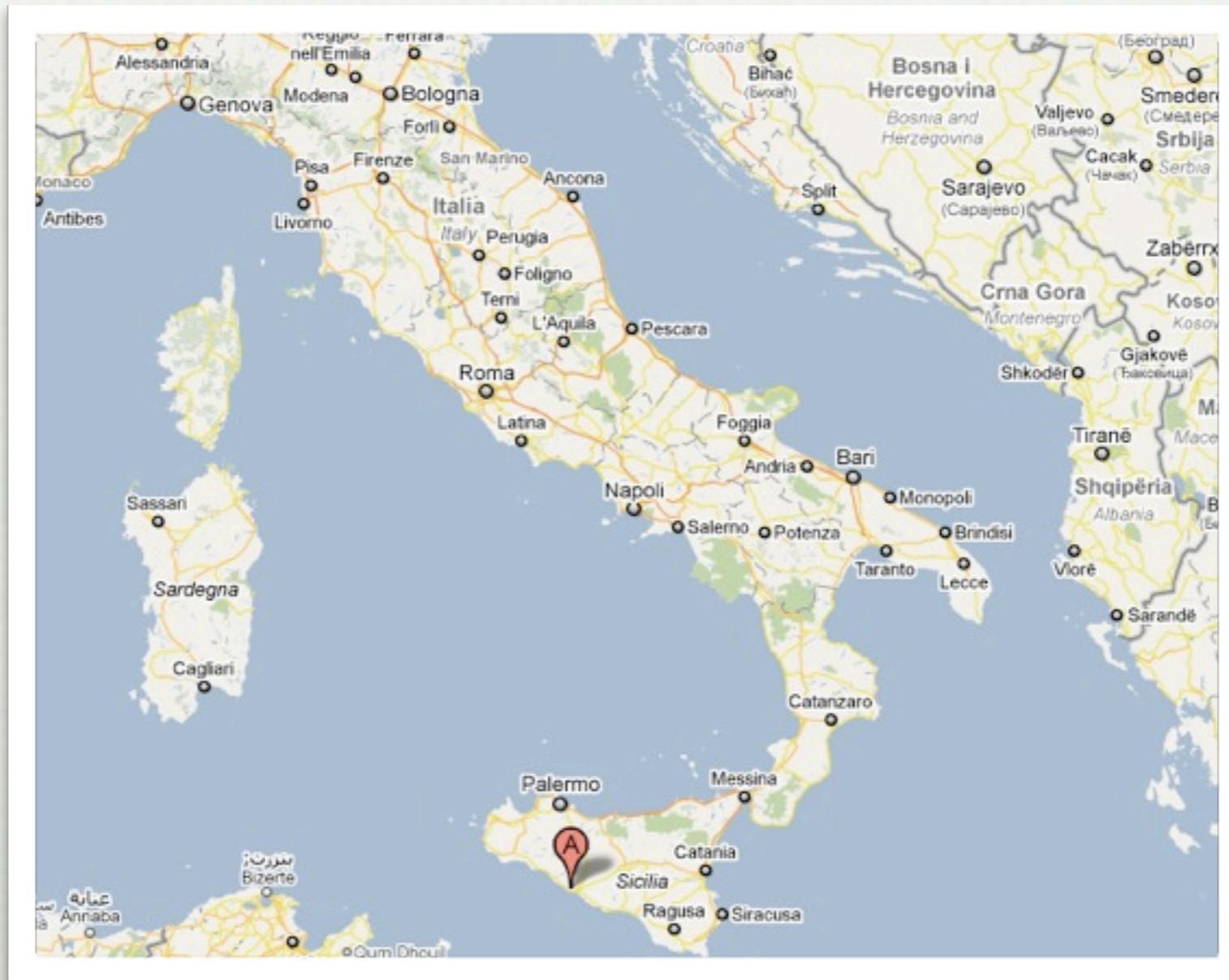
GERMANY:
HARZ MOUNTAINS

FINLAND:
PYHARJAVI

UK:
BOUBLY

CANDIDATE SITES

- ITALY:
SICILY, REALMONTE



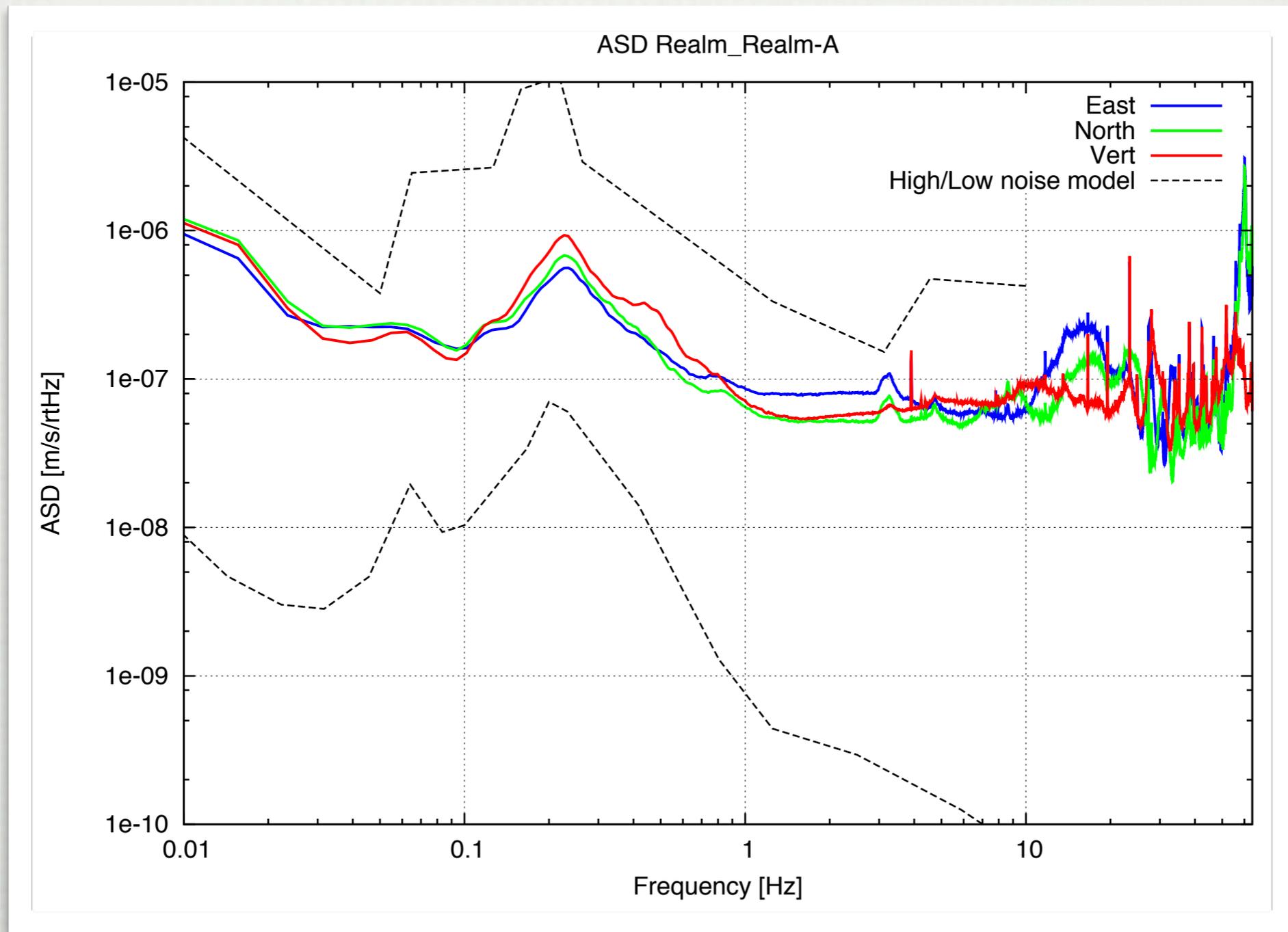
CANDIDATE SITES



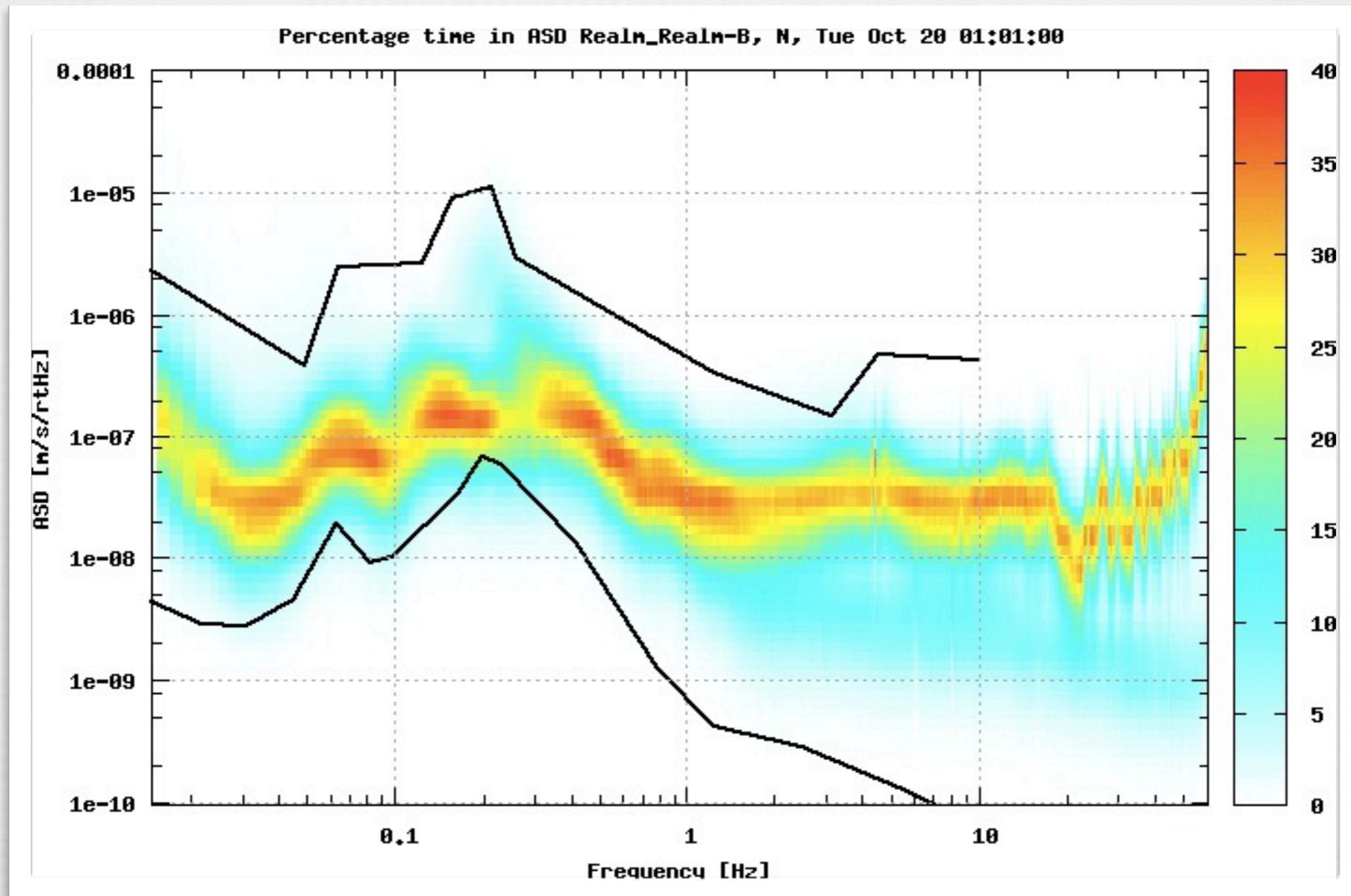
CANDIDATE SITES

- ITALY:
SICILY, REALMONTE
- SITE CHARACTERISTICS:
 - Currently used as a salt mine.
 - Located in Realmonte.
 - Seismic stations were at 40m deep.
 - Deepest point approximately 100m.
 - Local population density is 222 /km² (Realmonte 20.40km²)
 - Distance from sea or oceans is approx. 100m
- SITE MEASUREMENTS:
10/10/2009 UNTIL 16/10/2009

CANDIDATE SITES

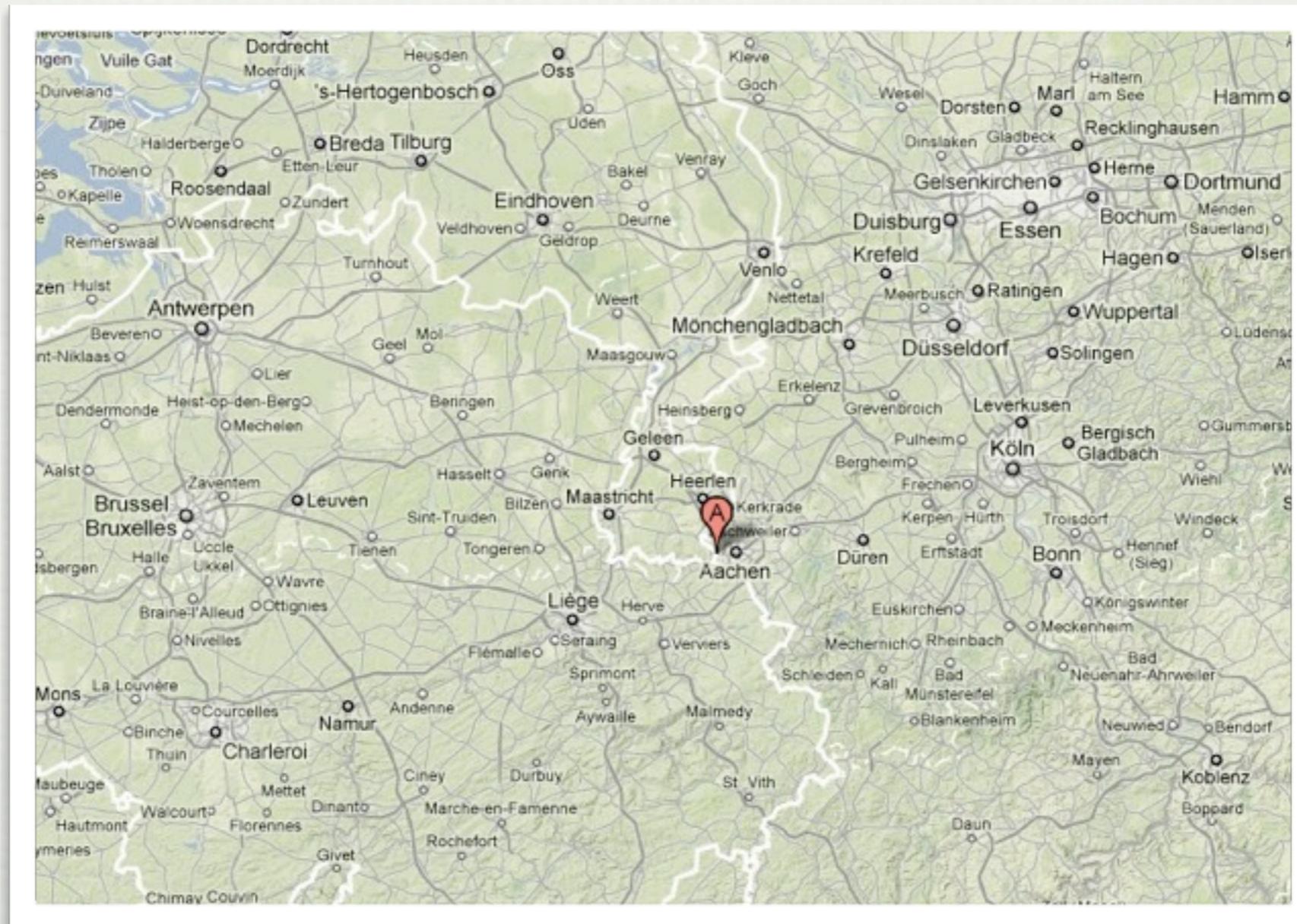


CANDIDATE SITES



CANDIDATE SITES

- THE NETHERLANDS:
LIMBURG, HEIMANSGROEVE



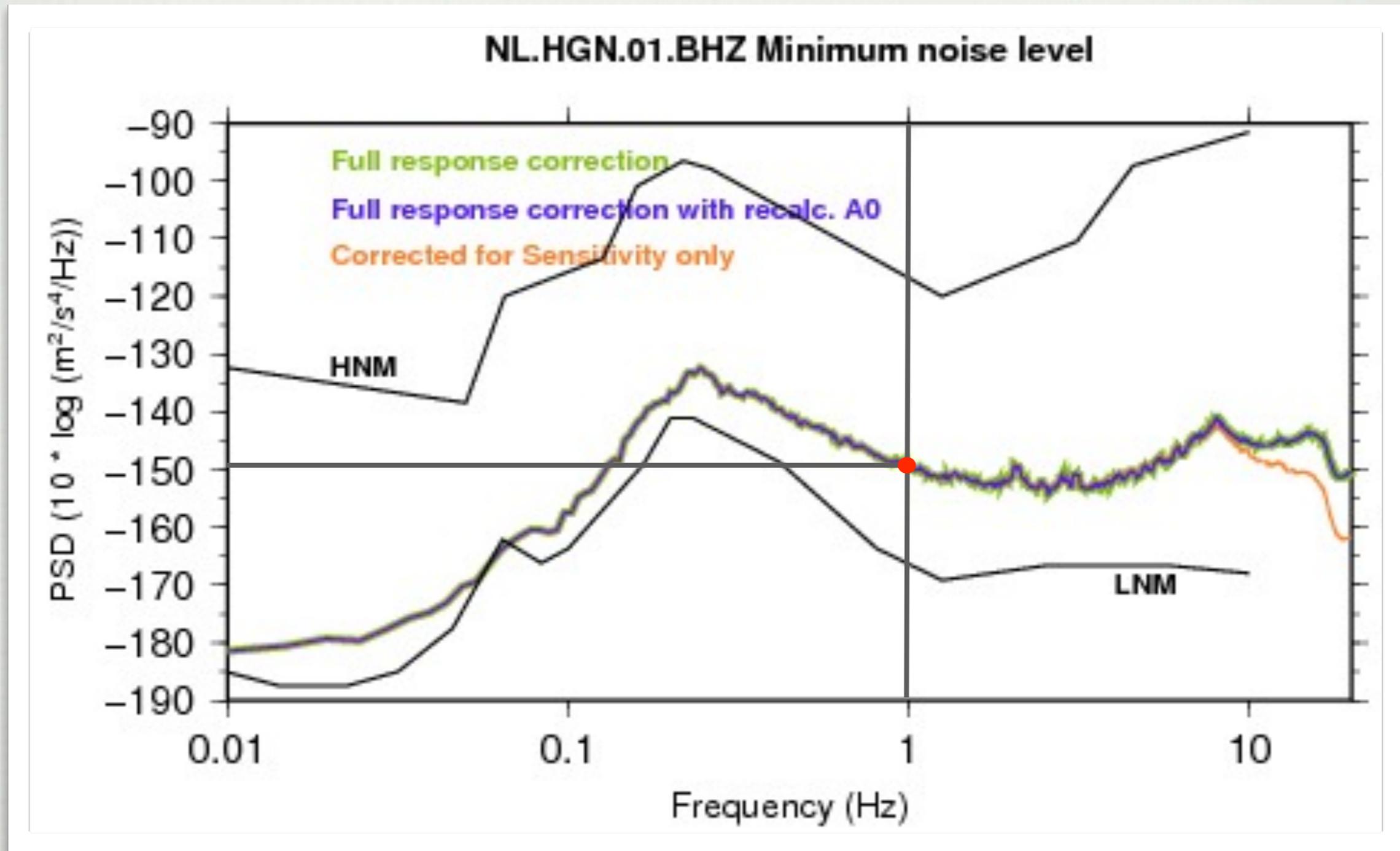
CANDIDATE SITES



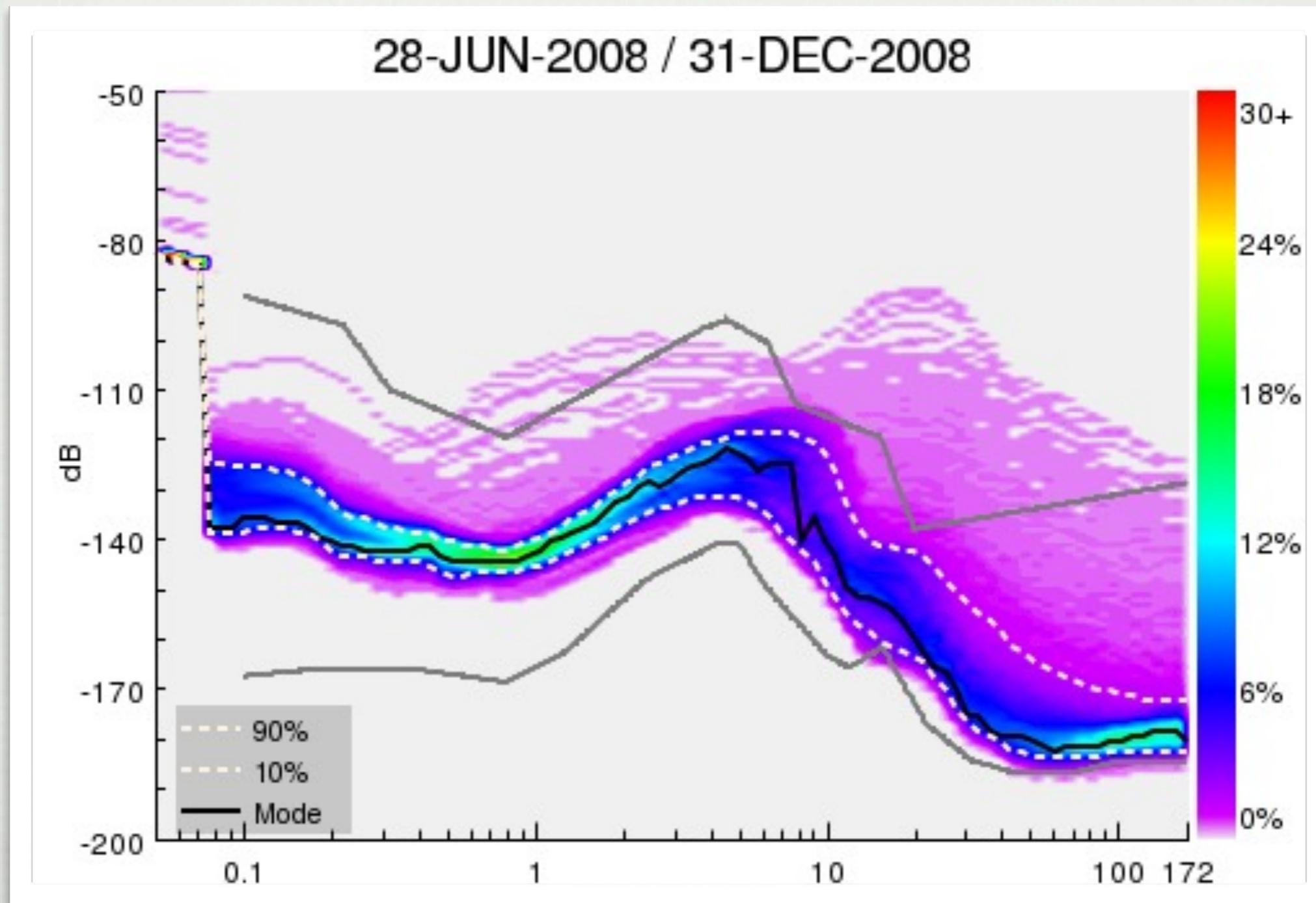
CANDIDATE SITES

- THE NETHERLANDS:
LIMBURG, HEIMANSGROEVE
- SITE CHARACTERISTICS:
 - Not used other than for seismic and geologic studies by the Dutch bureau of meteorology.
 - Local geology is lower carboniferous limestone (330Myear old).
 - Current seismic stations are at 10m deep.
 - Population density is 413/km². (city of vaals 23.90km²)
 - Distance from sea or ocean is approx 150km.
- SITE MEASUREMENTS:
11/03/2010 UNTIL 30/03/2010

CANDIDATE SITES

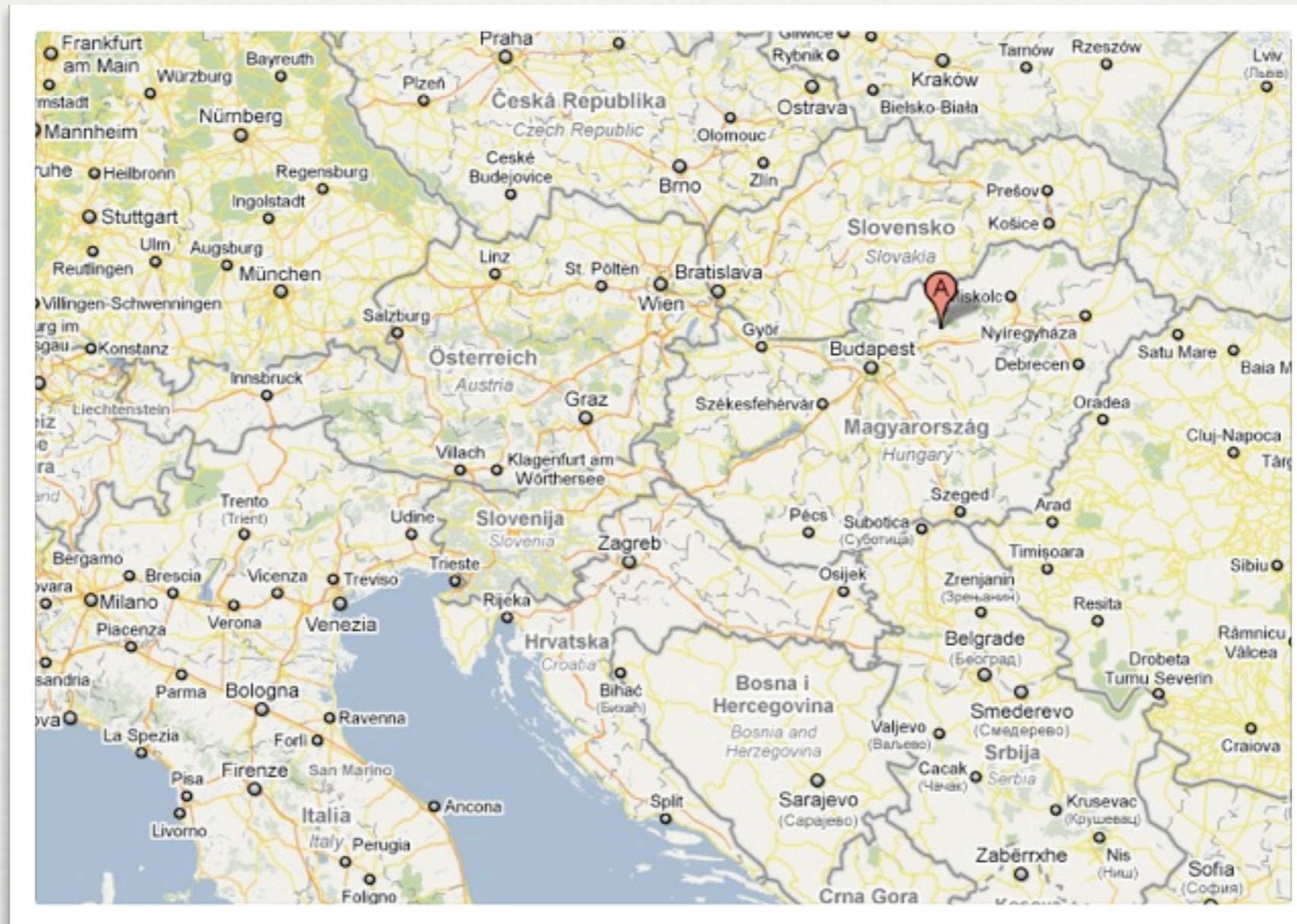


CANDIDATE SITES



CANDIDATE SITES

- HUNGARY:
GYÖNGYÖSOROSZI MINE (PROPOSED AT 2ND ET GM BY ISTVAN RACZ)



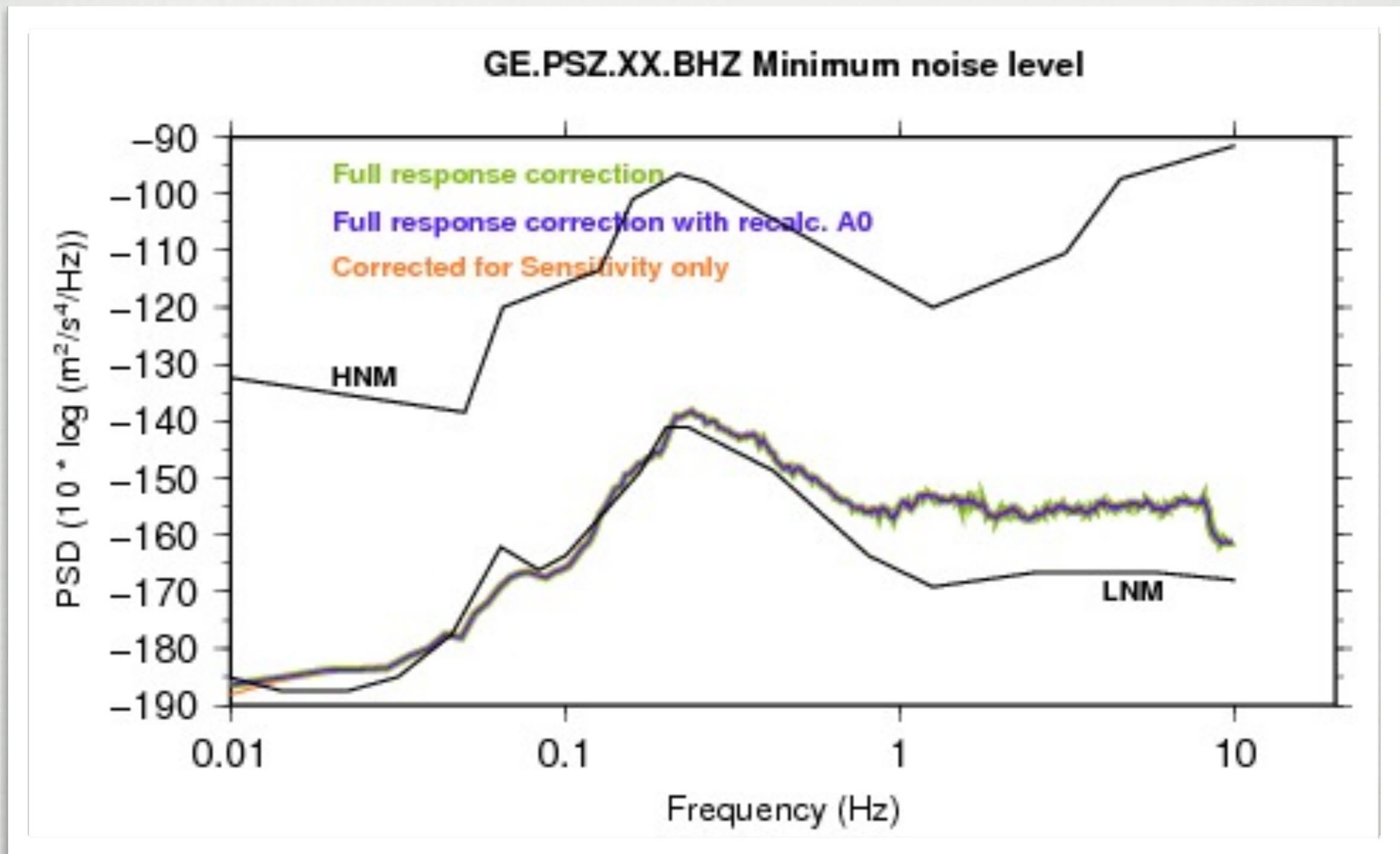
CANDIDATE SITES



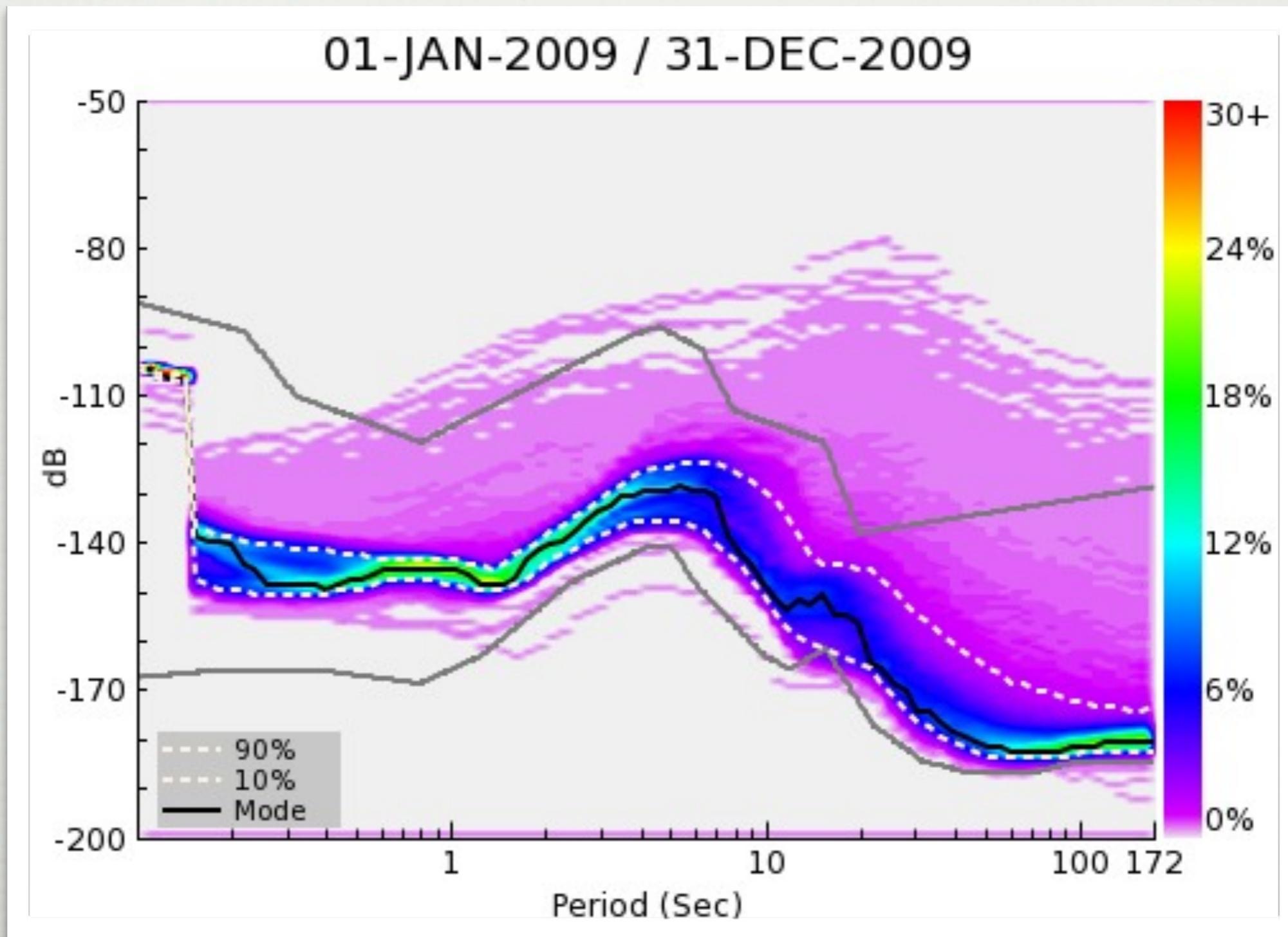
CANDIDATE SITES

- HUNGARY:
GYÖNGYÖSOROSZI MINE
- SITE CHARACTERISTICS:
 - Decommissioned lead mine.
 - Local geology is andesite (wave speed equal to granite)
 - Longest mine drift is approximately 3km.
 - Mine is at 330m depth.
 - Current seismic station is at approx 50m.
 - Local population density $75/\text{km}^2$ (Gyongyosroszi $21.39/\text{km}^2$)
 - Distance to sea or ocean is approximately 500km.
- SITE MEASUREMENTS:
01/04/2010 UNTIL 07/04/2010

CANDIDATE SITES

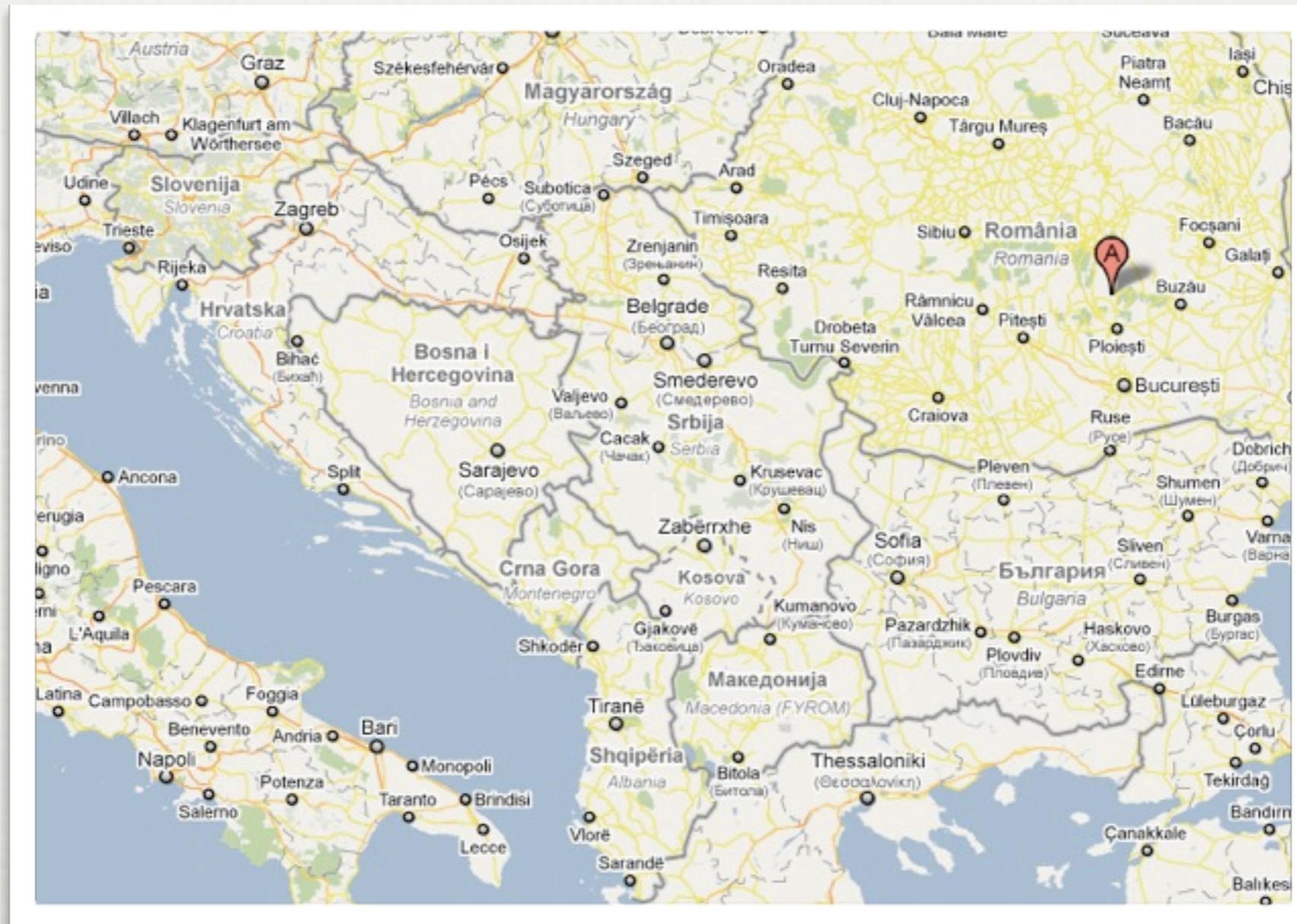


CANDIDATE SITES



CANDIDATE SITES

- ROMANIA:
SLANIC-PRAHOVA



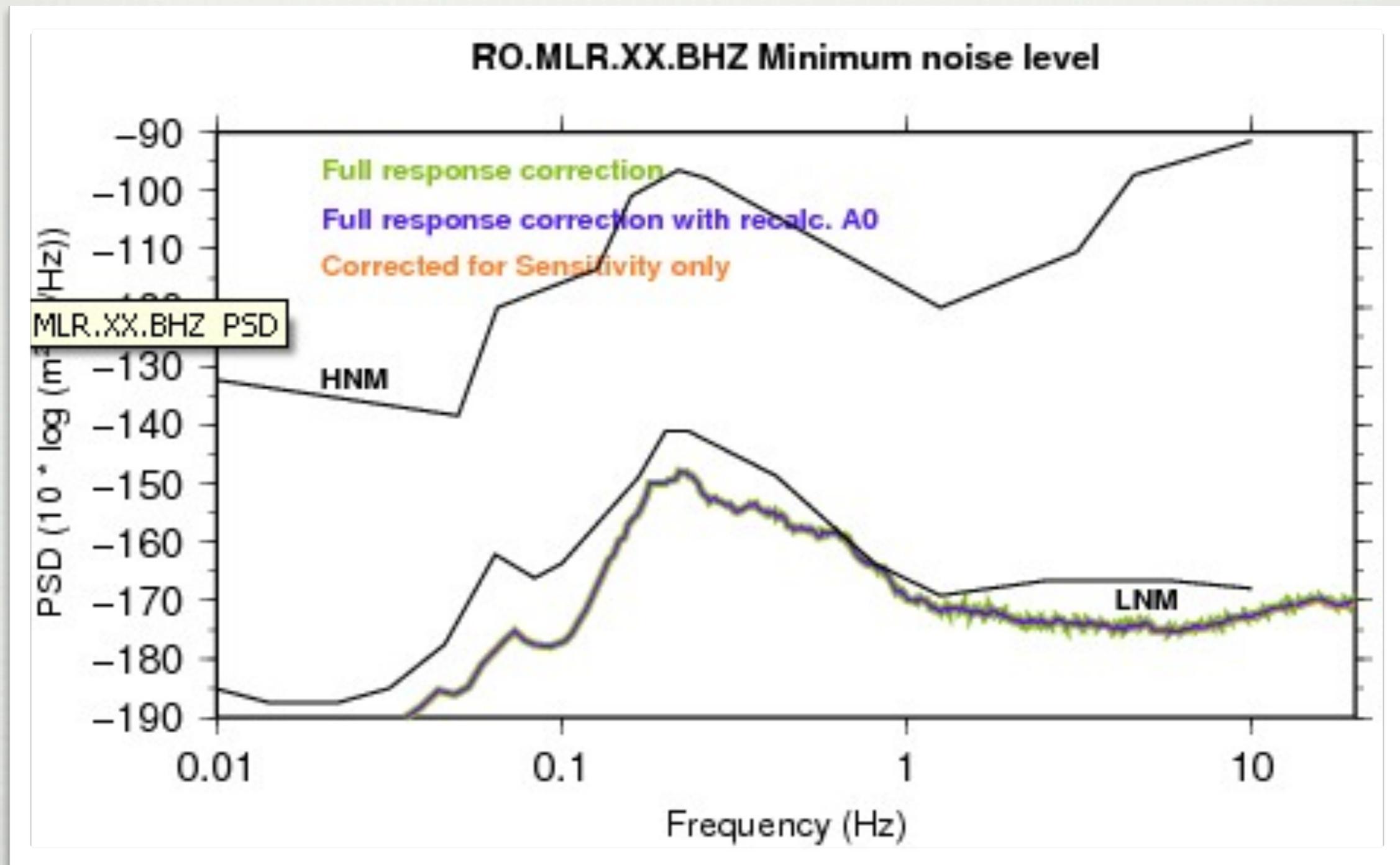
CANDIDATE SITES



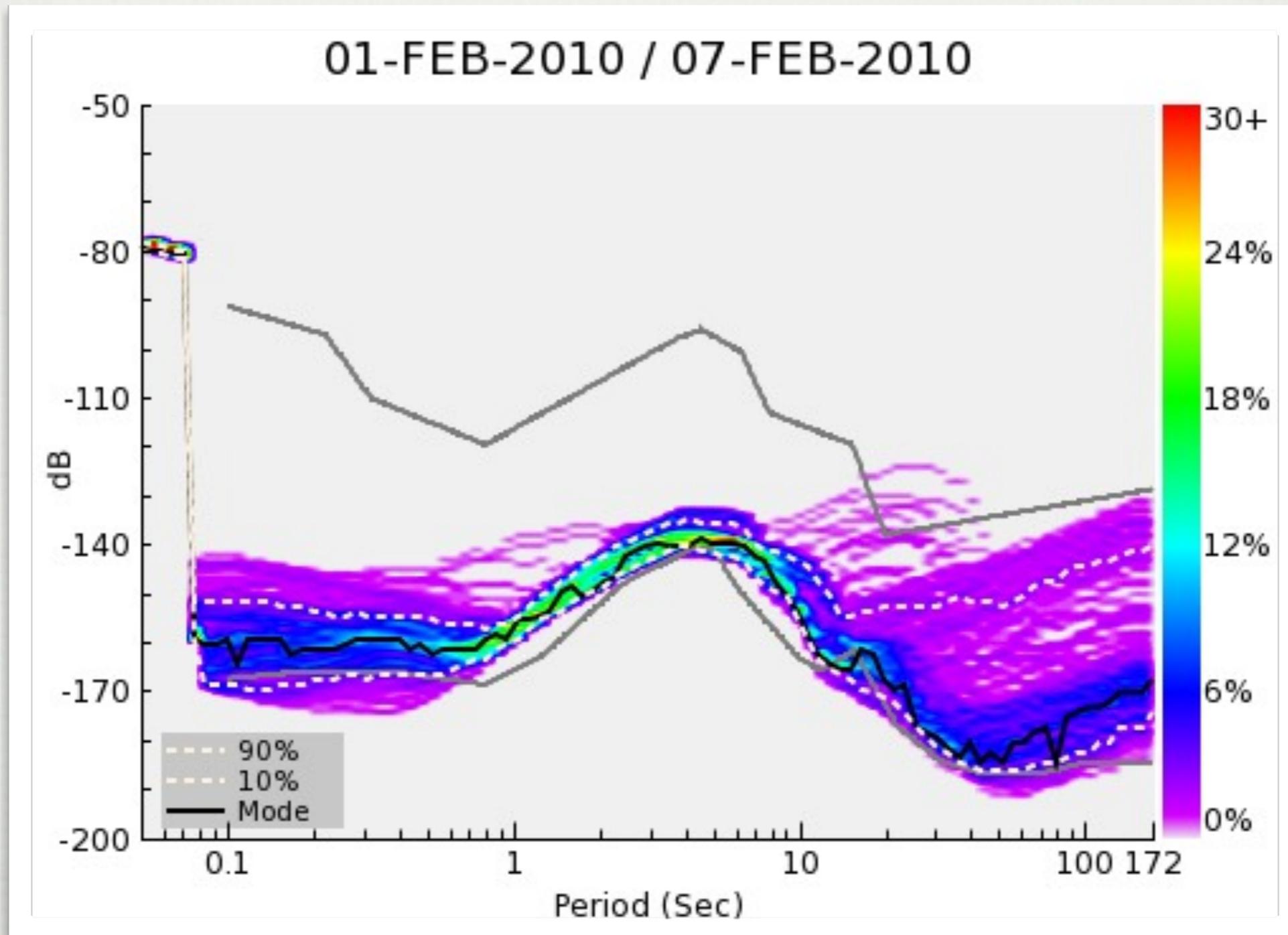
CANDIDATE SITES

- ROMANIA:
SLANIC-PRAHOVA
- SITE CHARACTERISTICS:
 - Decommissioned salt mine (largest salt mine in Europe)
 - Local geology is andesite.
 - Already contains some large caverns.
 - Current depth of seismic station is unknown.
 - Depth of mine is at a few hundreds of metres.
 - Local population density is $180/\text{km}^2$ (Slanic 40km^2).
 - Distance to sea or ocean is 300km.
- SITE MEASUREMENTS:
08/04/2010 UNTIL 14/04/2010

CANDIDATE SITES

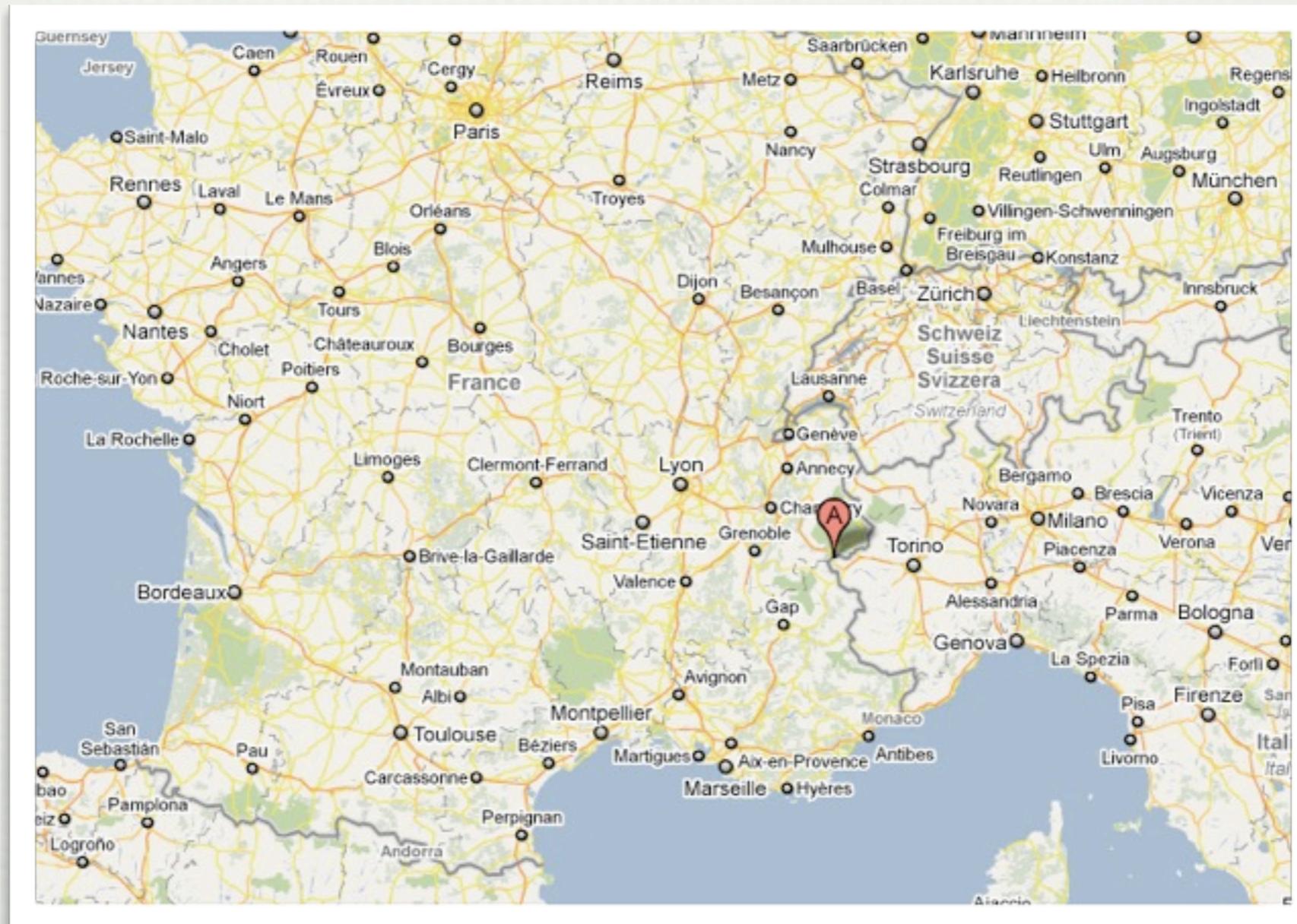


CANDIDATE SITES



CANDIDATE SITES

- FRANCE:
FREJUS (LABORATOIR SOUTERRAIN DE MONDANE)



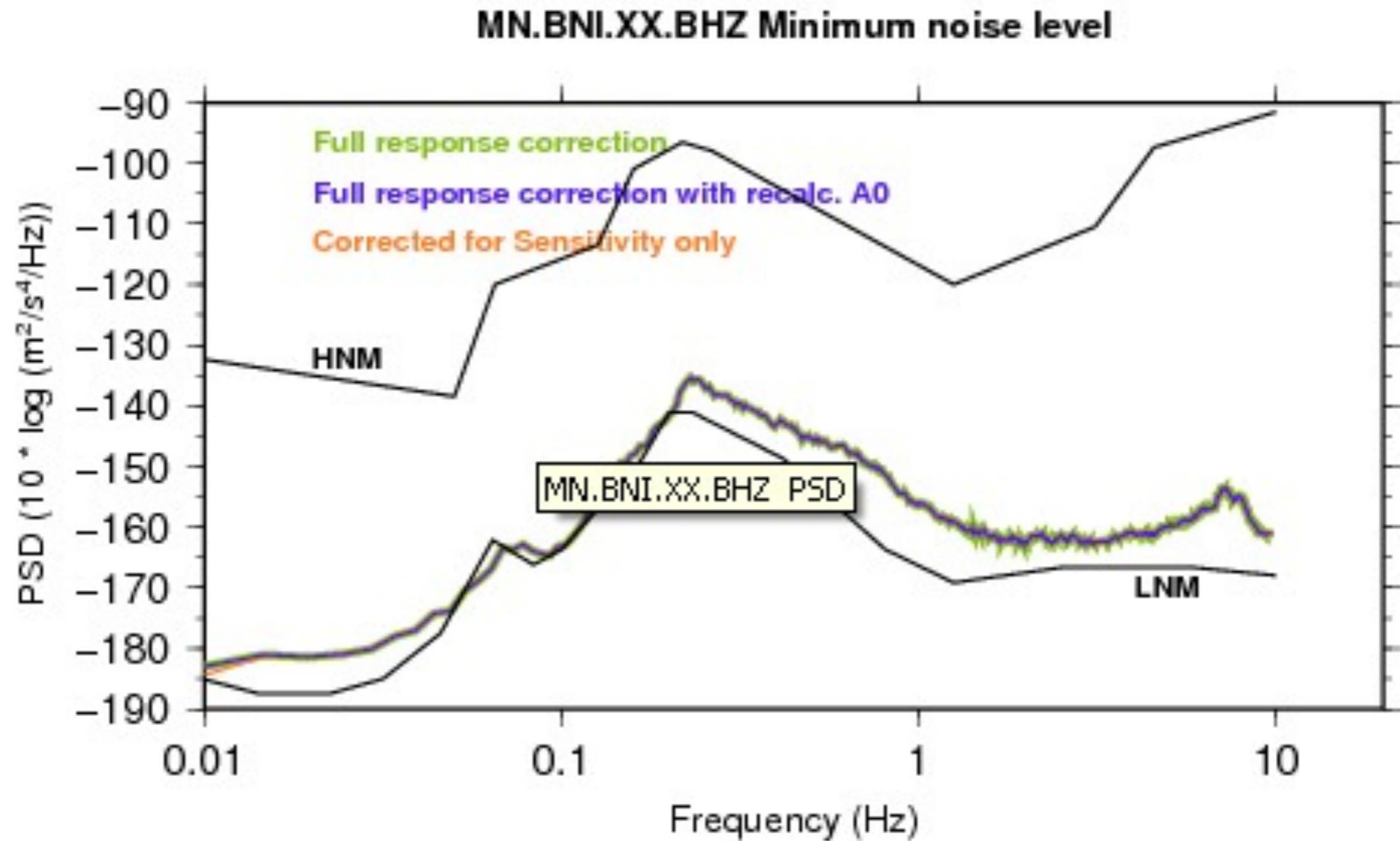
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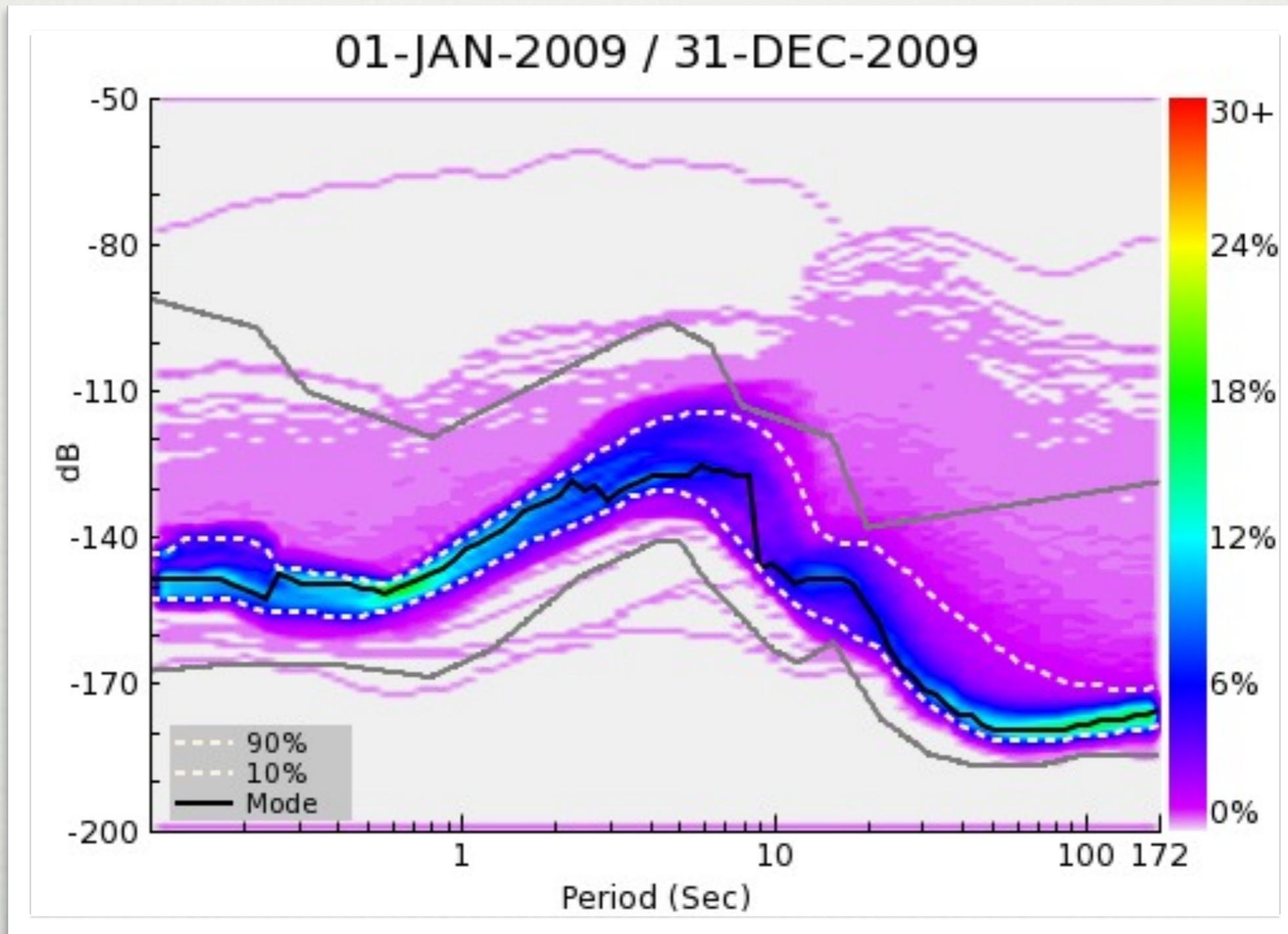
CANDIDATE SITES

- SPAIN:
FREJUS (LABORATOIR SOUTERRAIN DE MONDANE)
- SITE CHARACTERISTICS:
 - Currently used as an underground laboratory for low background environment to study neutrino properties and looking for dark matter.
 - Local geology is hard rock.
 - The laboratory is at 1700m (water equivalent) depth.
 - Current depth of seismic station is 1400m.
 - Population density is 512/km² (Charmaix 7km²).
 - Distance to sea or ocean is 200km.
- SITE MEASUREMENTS:
16/04/2010 UNTIL 25/04/2010

CANDIDATE SITES

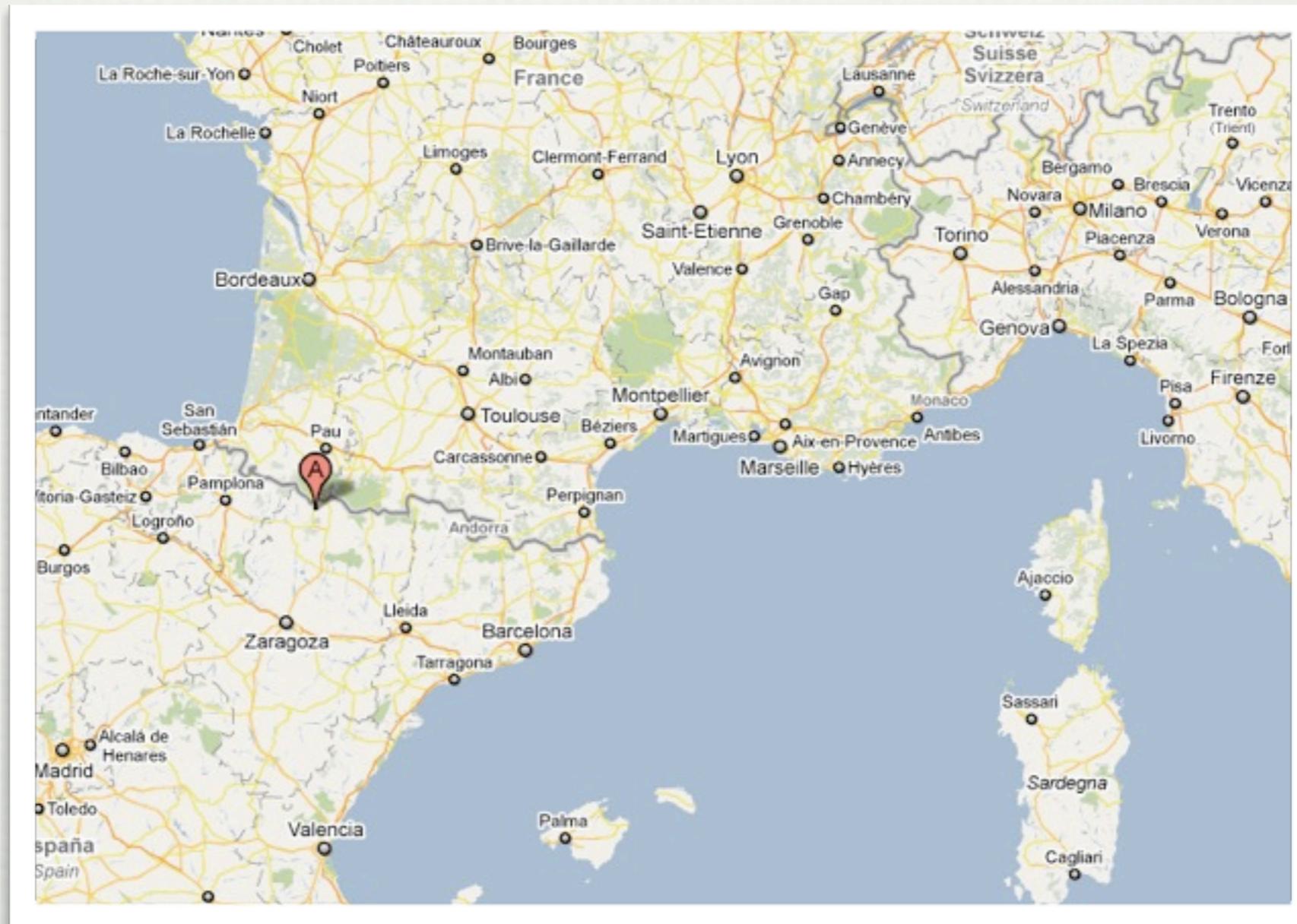


CANDIDATE SITES



CANDIDATE SITES

- SPAIN:
LABORATORIO SUBTERRANEO DE CANFRANC



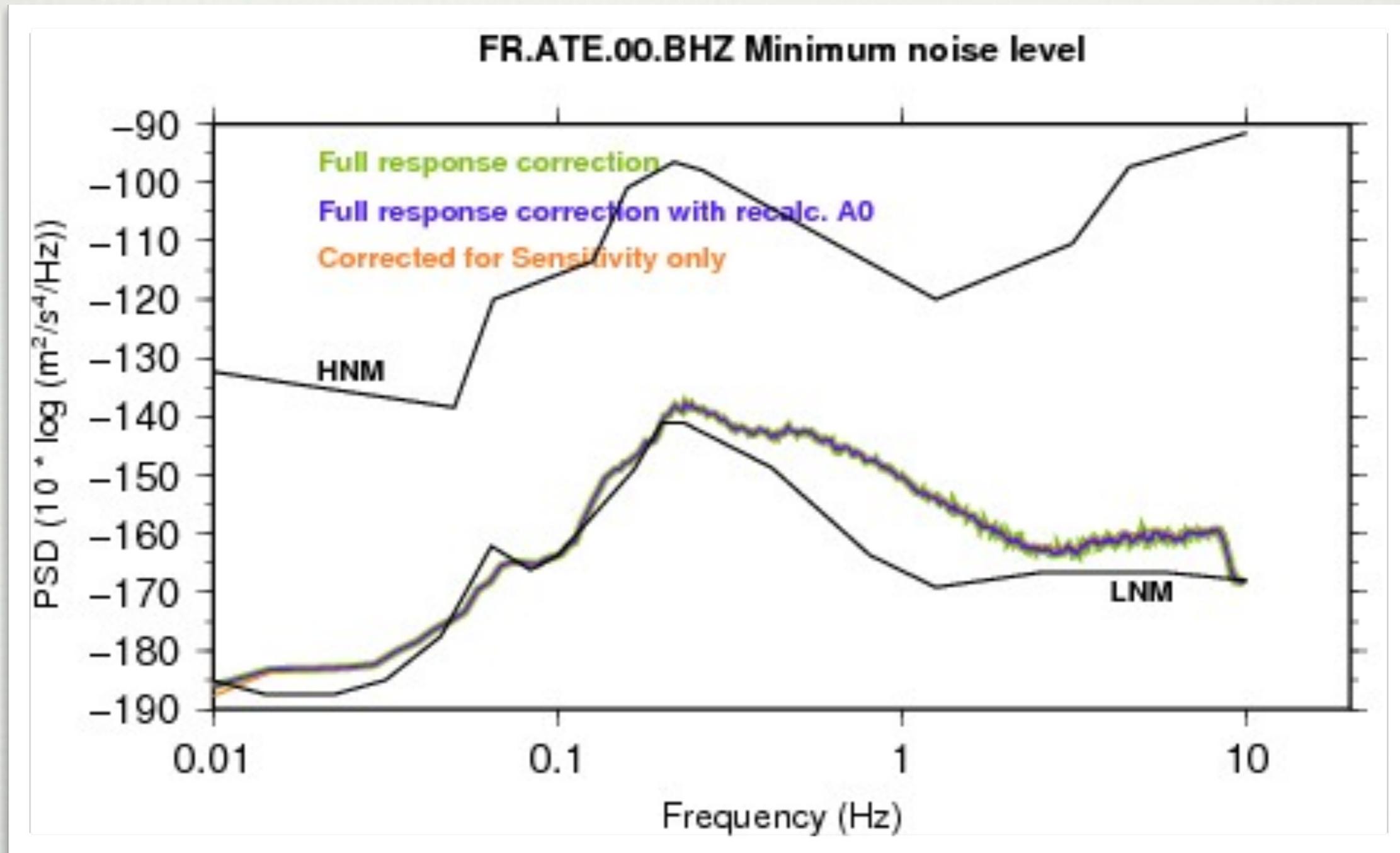
CANDIDATE SITES



CANDIDATE SITES

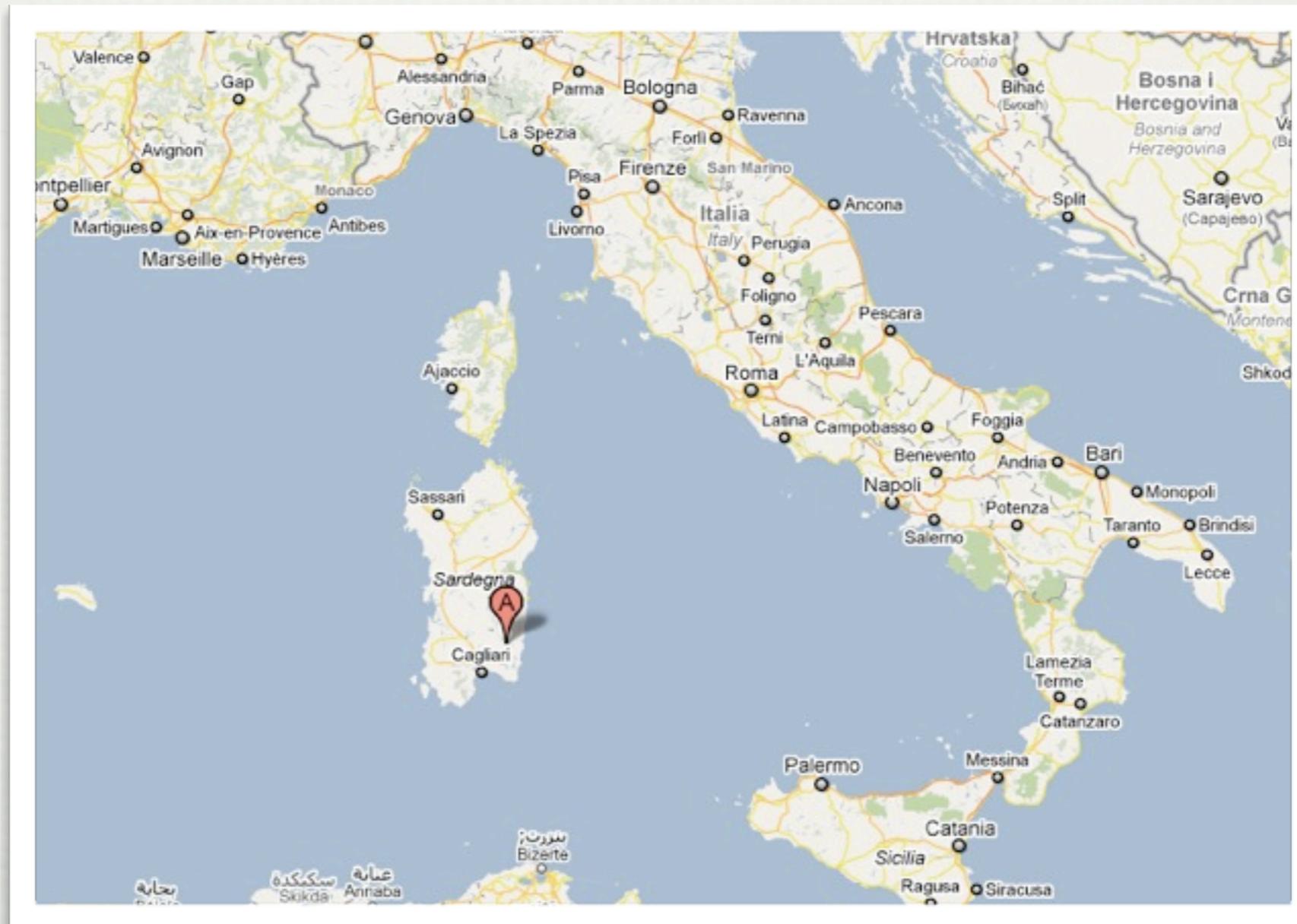
- SPAIN:
LABORATORIO SUBTERRANEO DE CANFRANC
- SITE CHARACTERISTICS:
 - Currently used as an underground lab for particle physics.
 - Local geology is soft rock.
 - The laboratory is at 1400m (water equivalent) depth.
 - Current depth of seismic station is at 2km.
 - Population density is $1.35/\text{km}^2$ (Canfranc 72km^2).
 - Distance to sea or ocean is 120km.
- SITE MEASUREMENTS:
26/04/2010 UNTIL 02/05/2010

CANDIDATE SITES

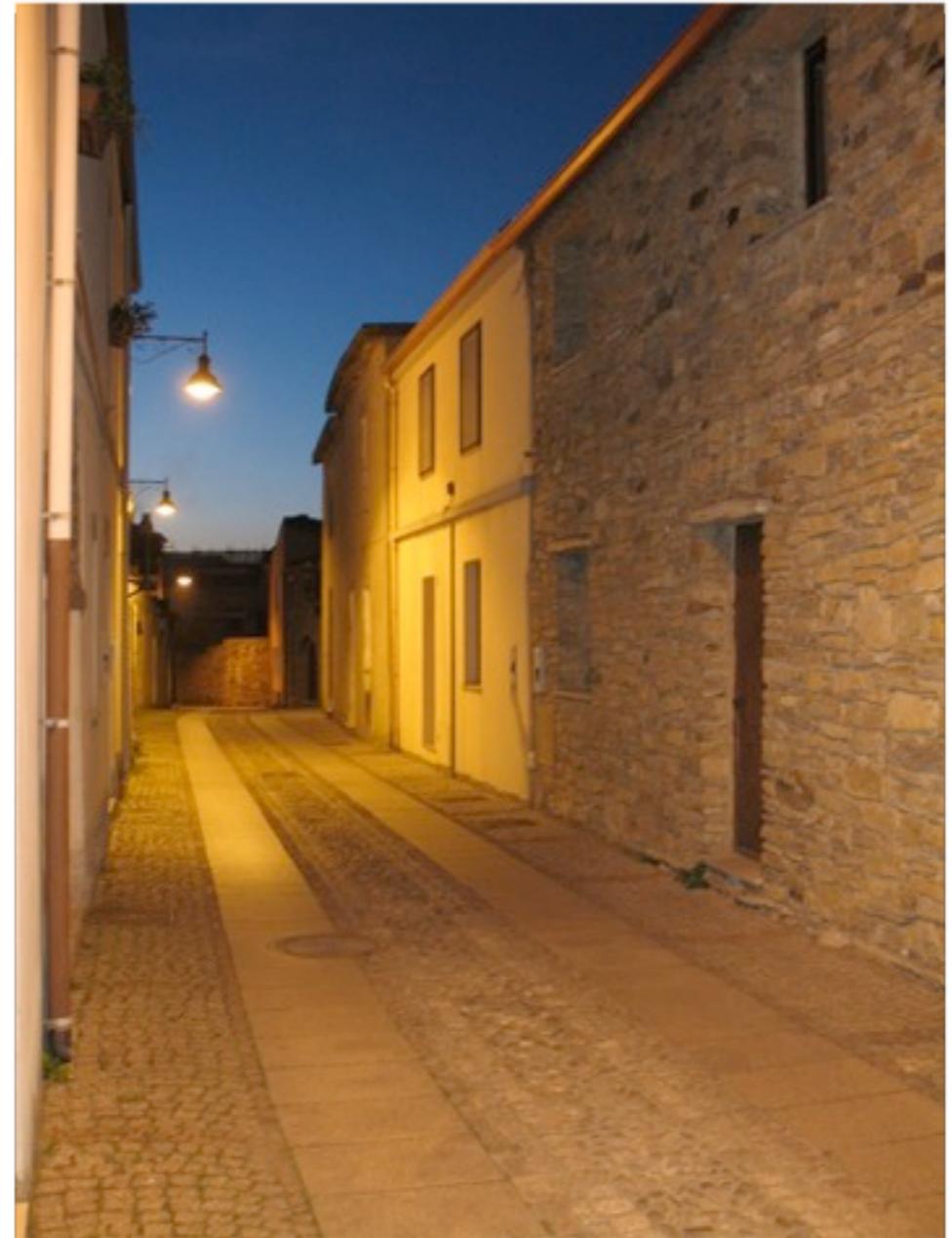


CANDIDATE SITES

- ITALY:
SARDINIA



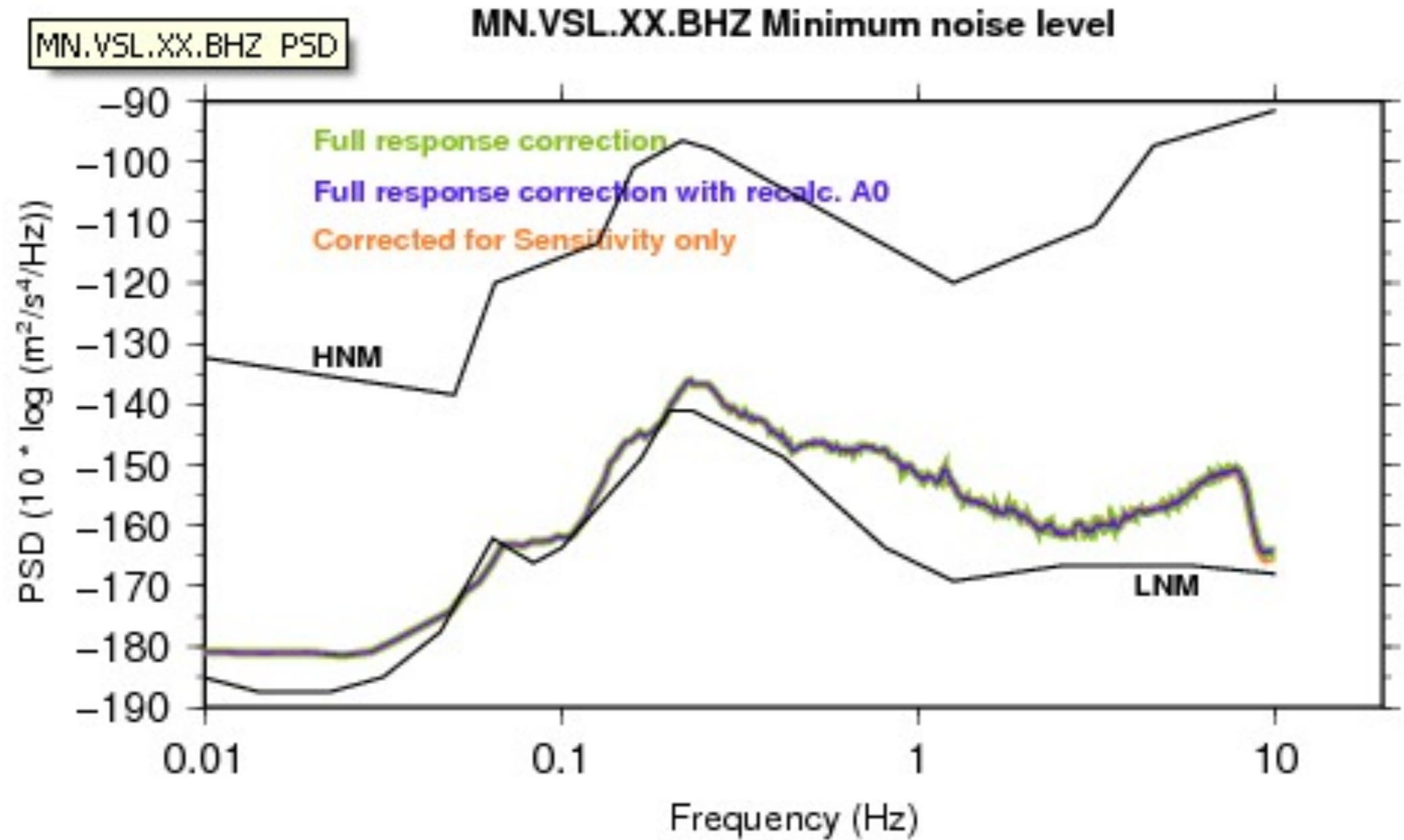
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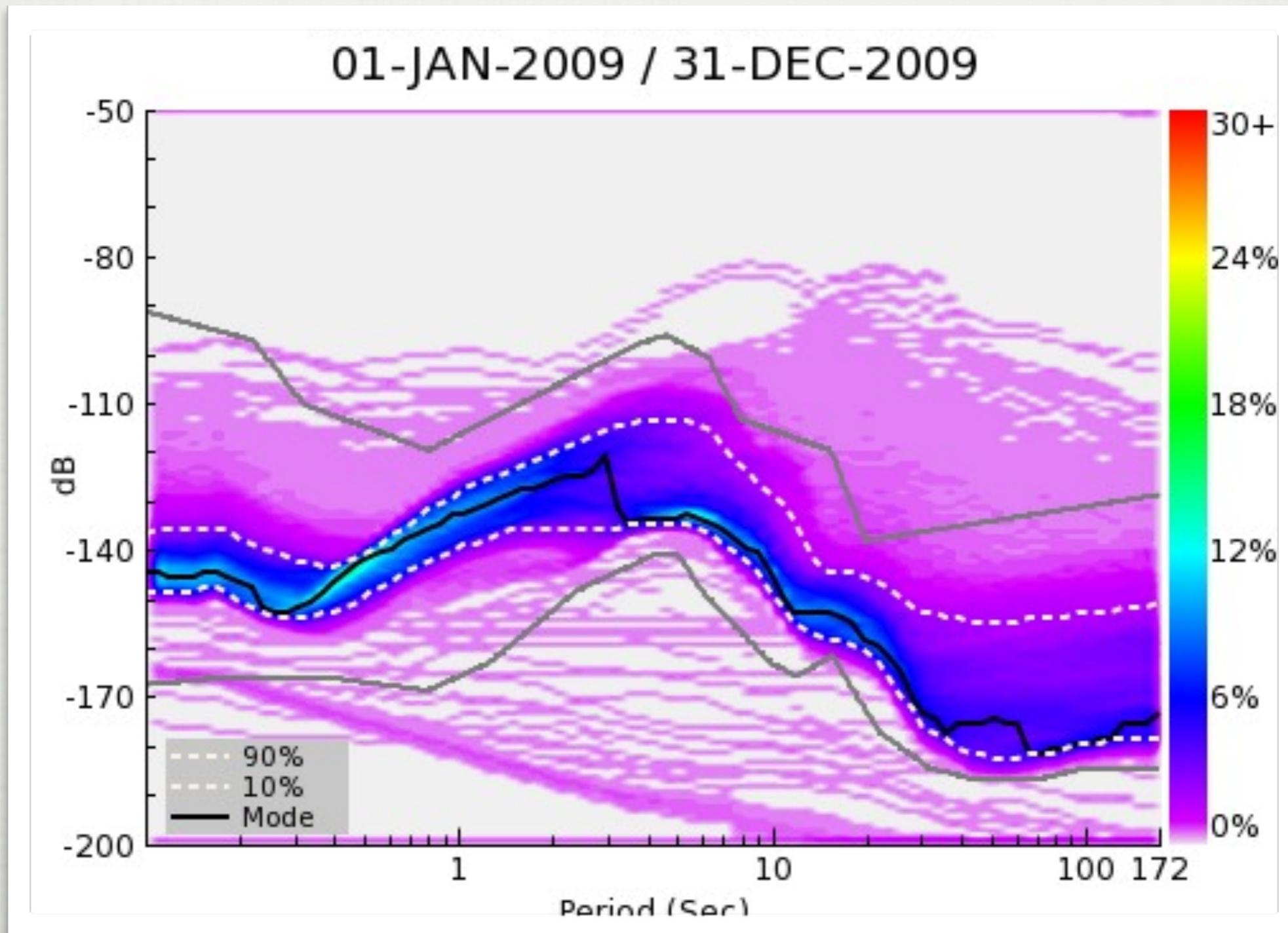
CANDIDATE SITES

- ITALY:
SARDINIA
- SITE CHARACTERISTICS:
 - Site is a former coal mine.
 - Local geology hard rock
 - Current depth of seismic station is 20m.
 - Local population density is $10.1/\text{km}^2$ (Villasalto 130.1km^2)
 - Distance to sea or ocean is approximately 10km.
- SITE MEASUREMENTS:
MID 2010

CANDIDATE SITES

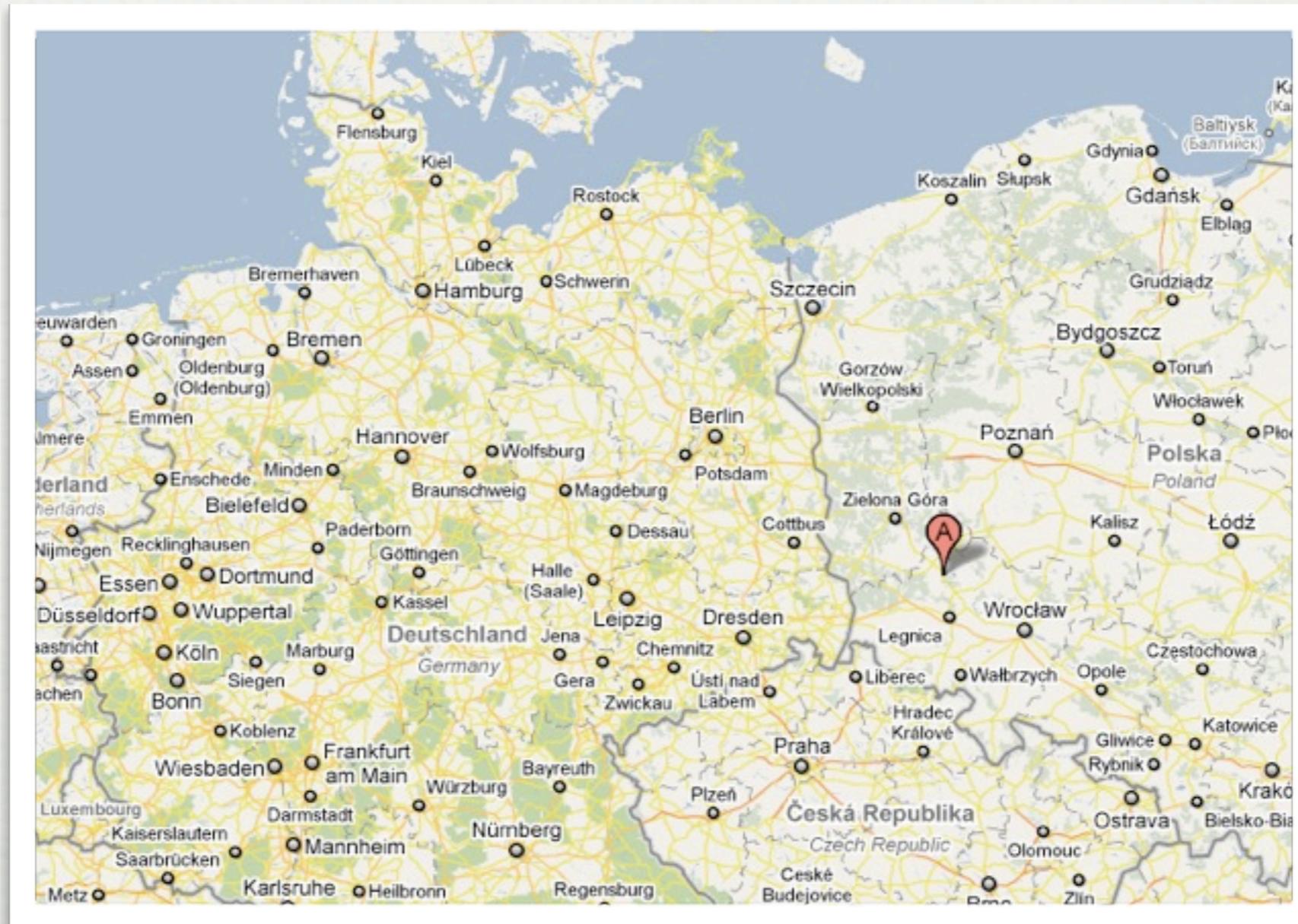


CANDIDATE SITES



CANDIDATE SITES

- POLAND:
POLKOWICE-SIEROZOSWICE MINE



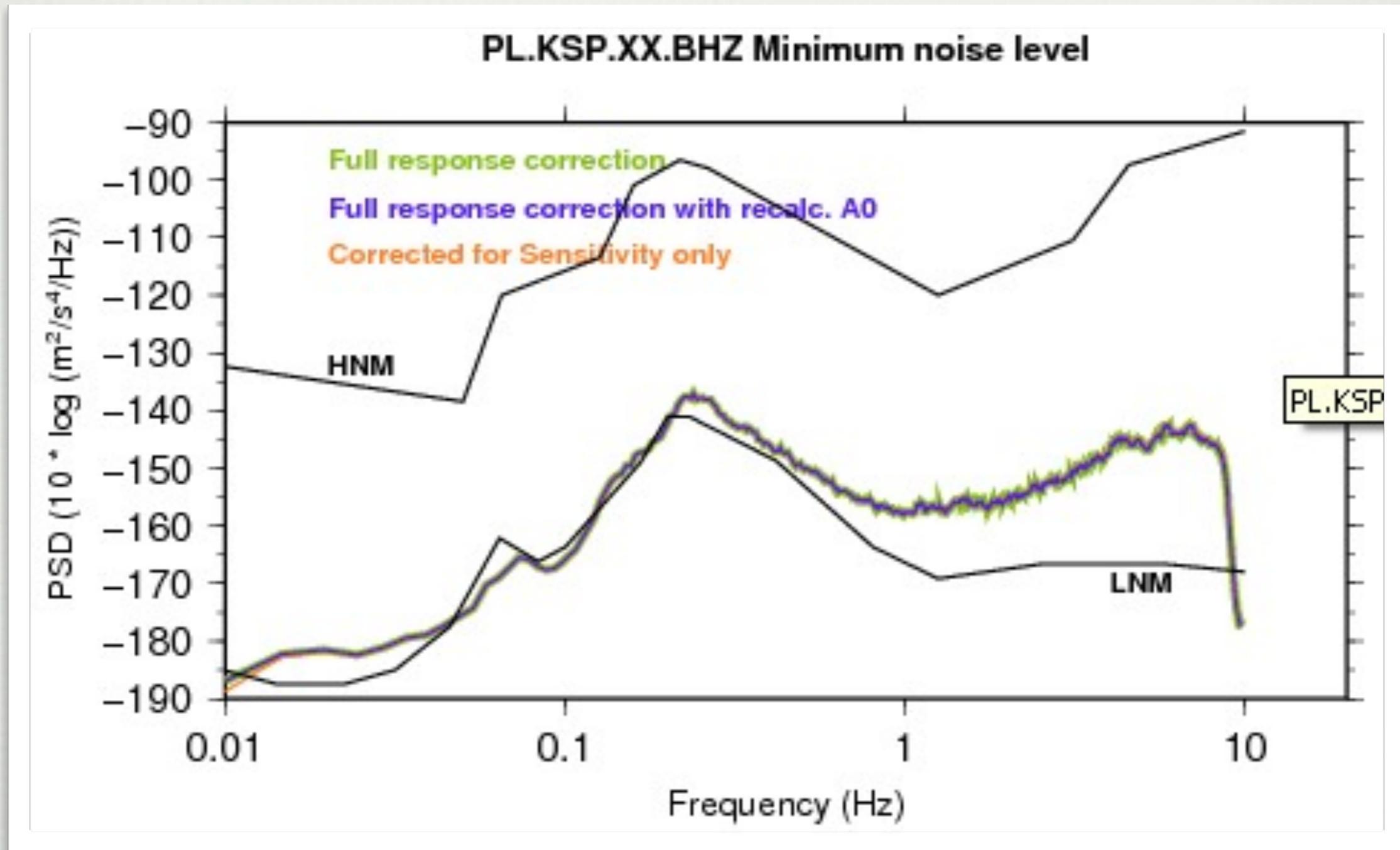
CANDIDATE SITES



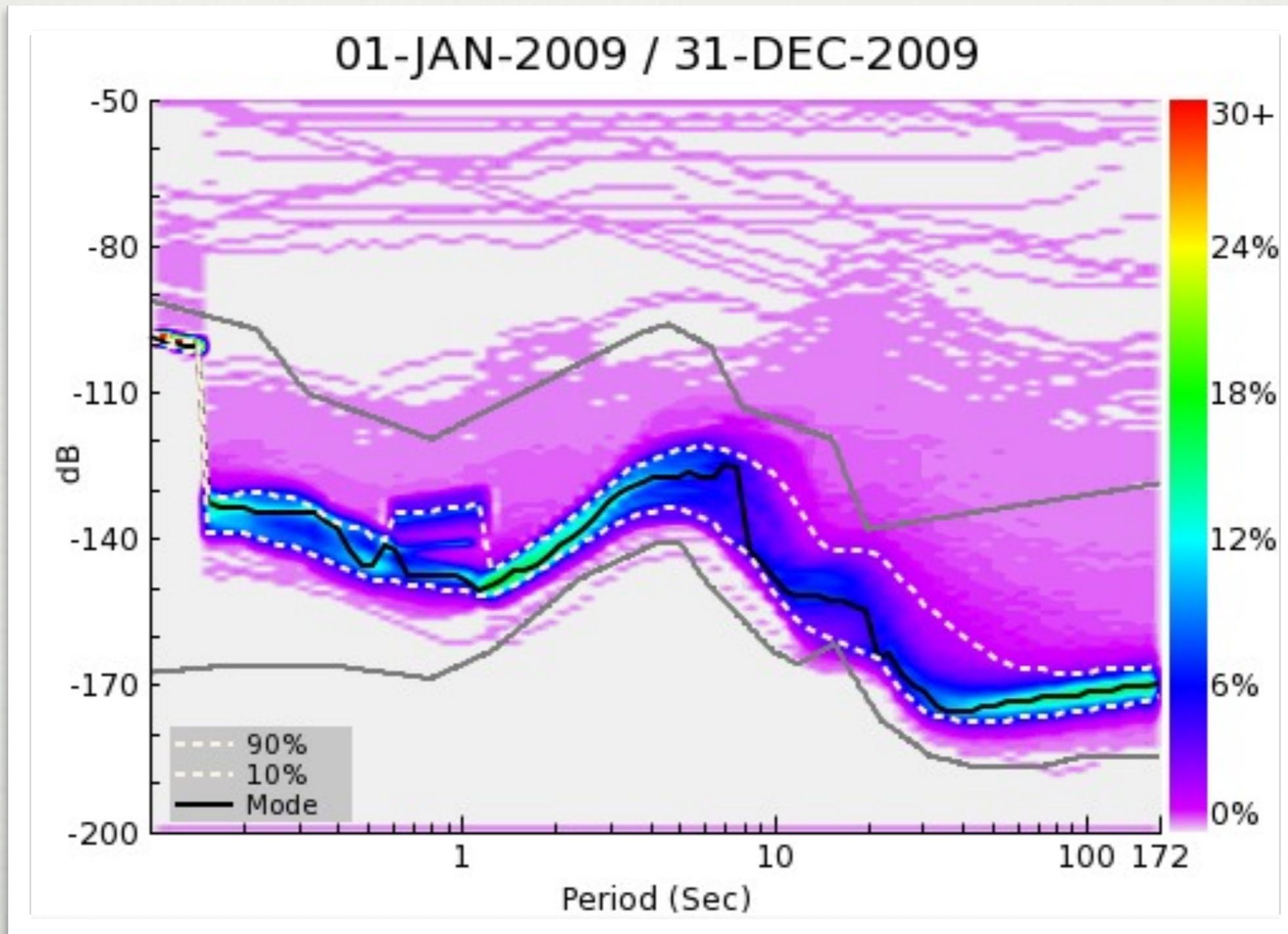
CANDIDATE SITES

- POLAND:
POLKOWICE-SIEROZOSWICE MINE
- SITE CHARACTERISTICS:
 - Operational copper mine.
 - Local geology hard rock.
 - Mine depth is 950m (2200m water equivalent).
 - Local population density 938.1/km² (Polkowice 23.75km²).
 - Distance to sea or ocean 350km.
- SITE MEASUREMENTS:
MID 2010

CANDIDATE SITES

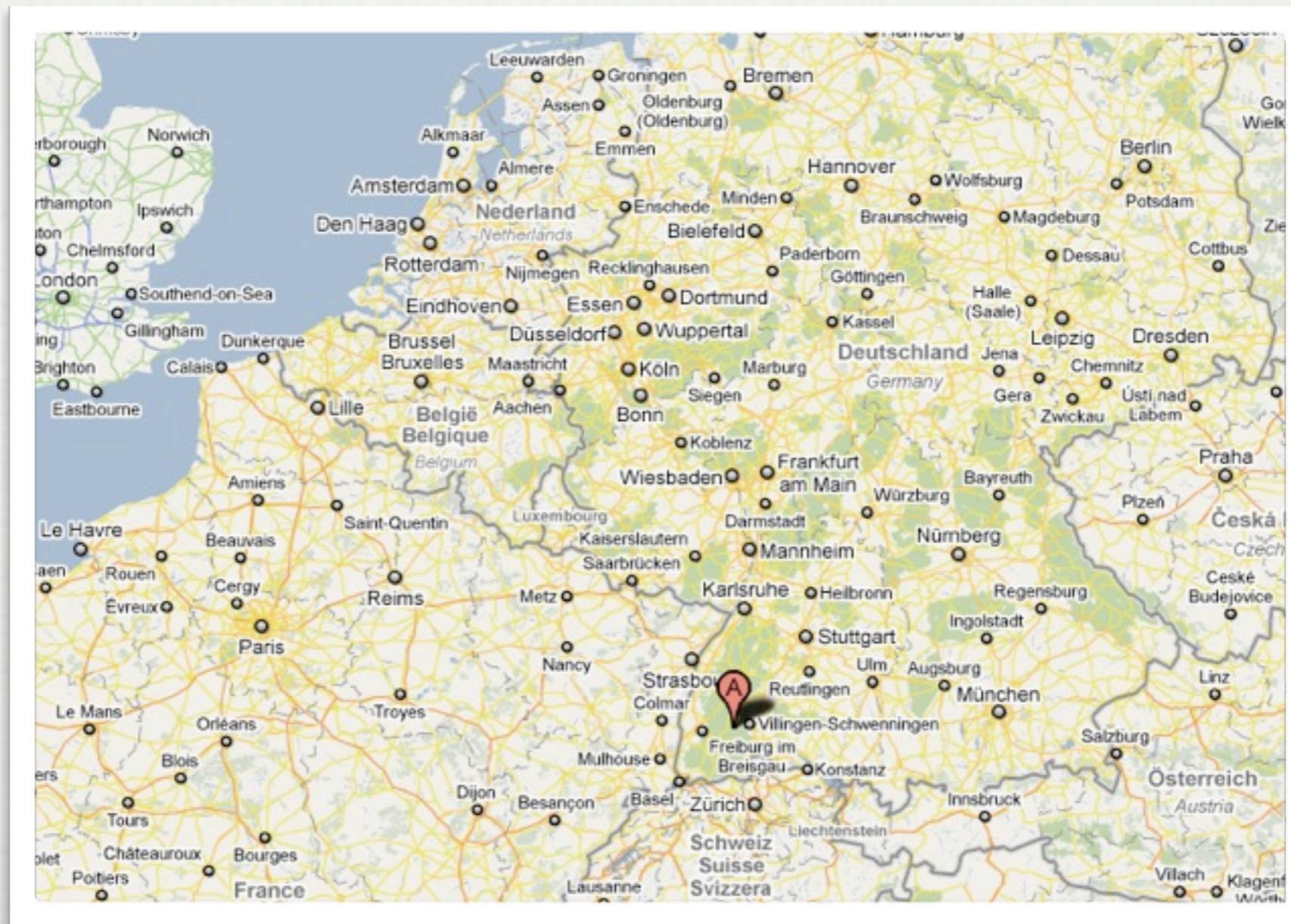


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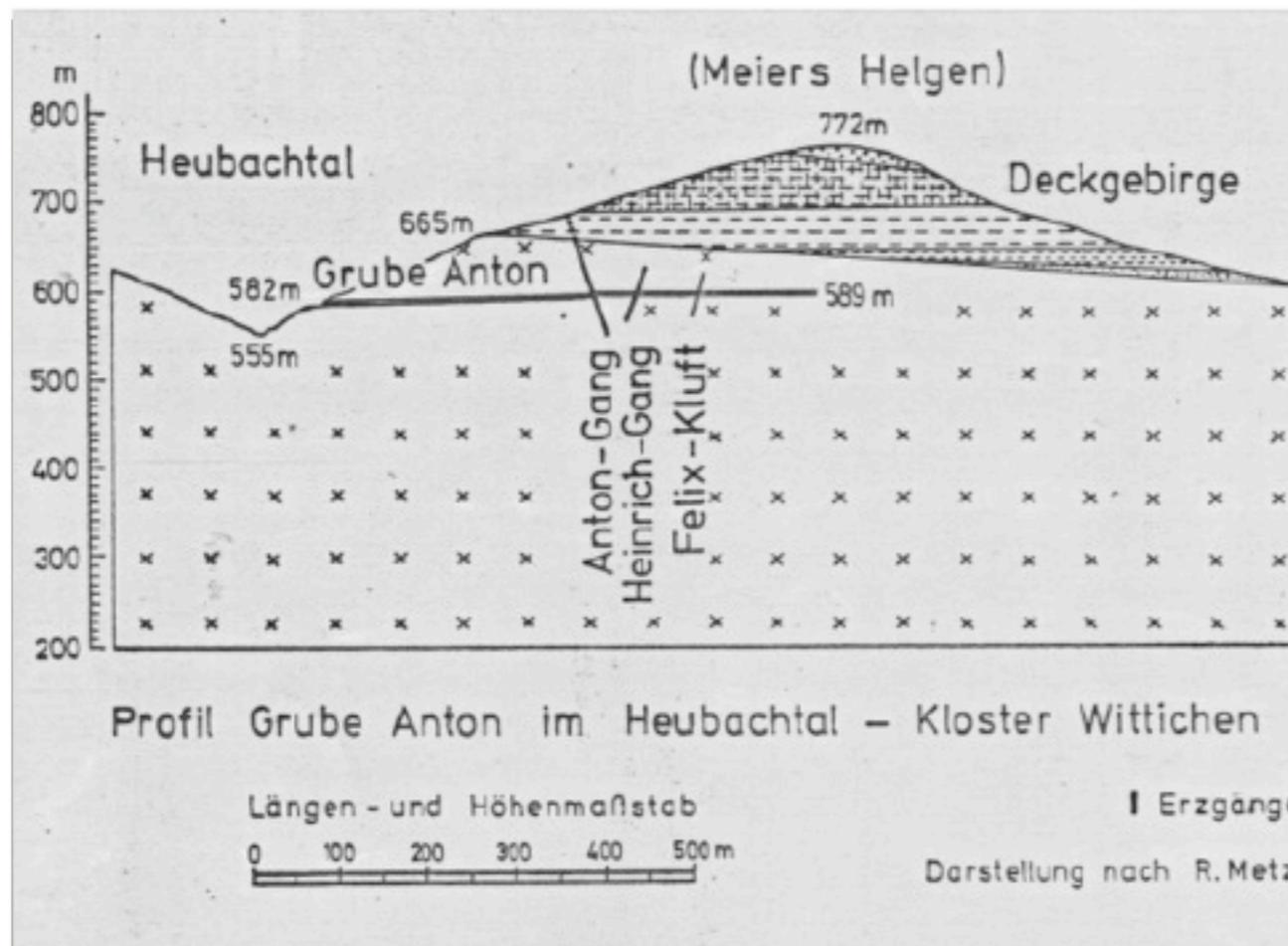


CANDIDATE SITES

- GERMANY:
BLACK FOREST OBSERVATORY



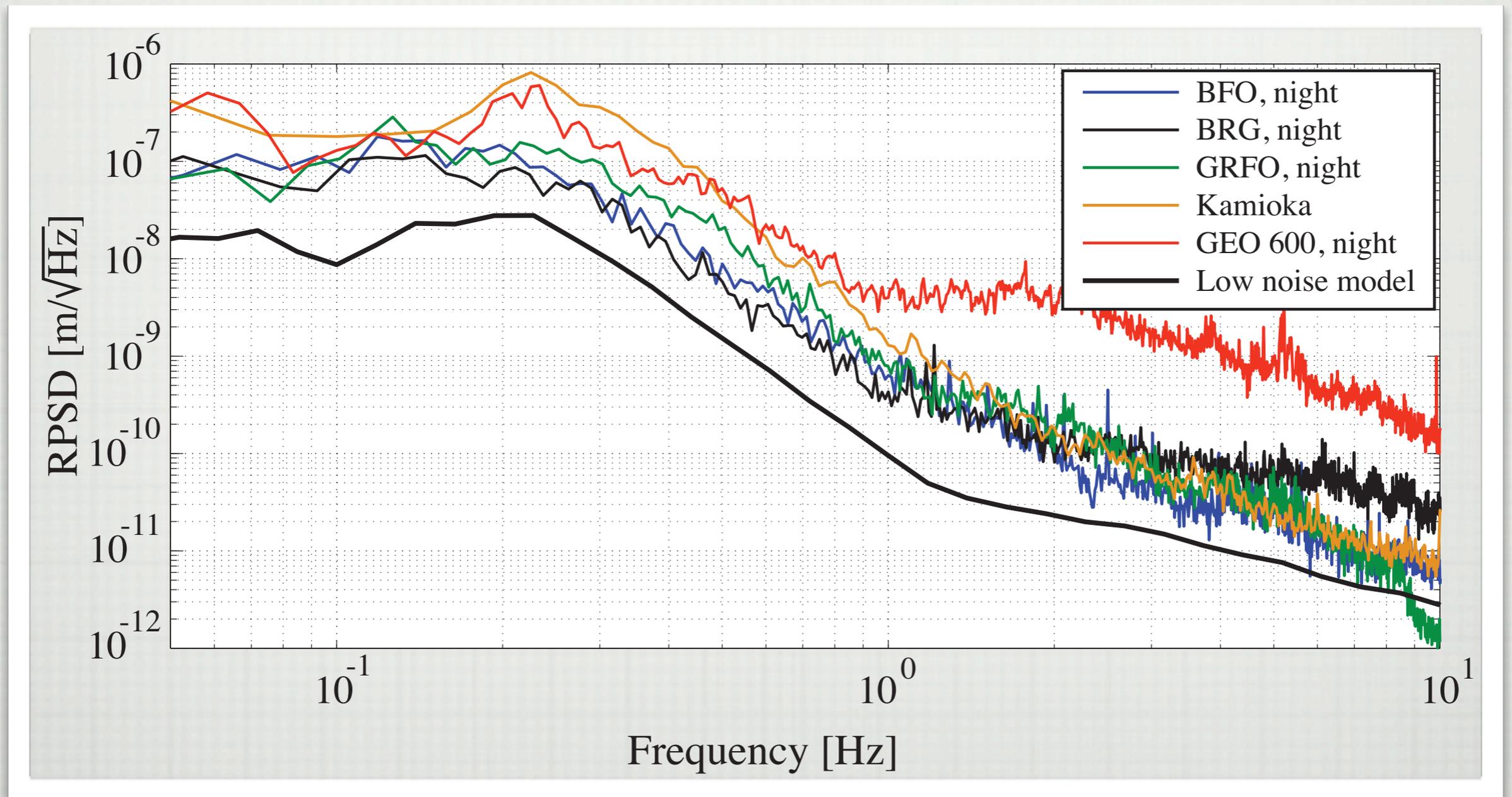
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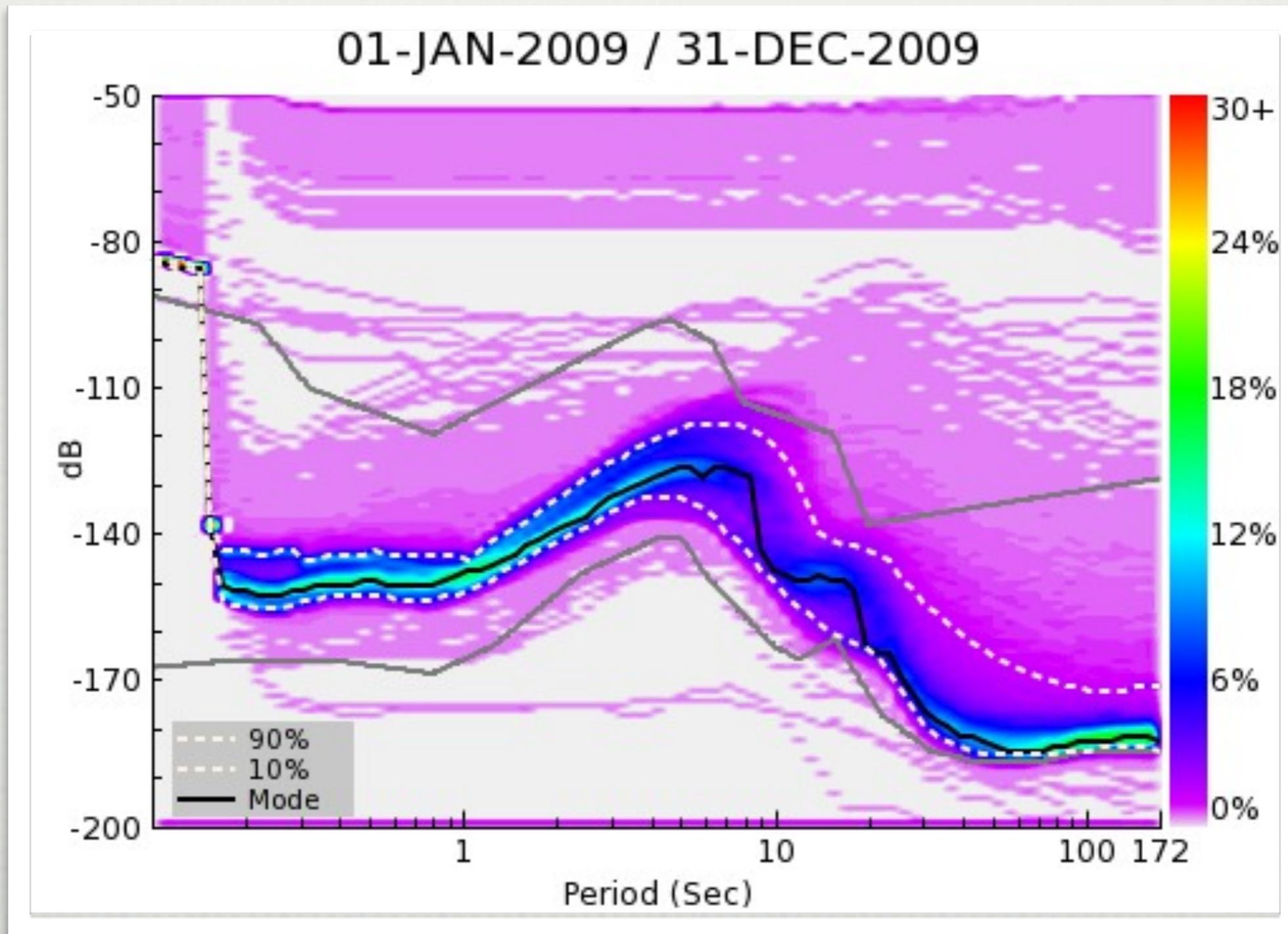
CANDIDATE SITES

- GERMANY:
BLACK FOREST OBSERVATORY
- SITE CHARACTERISTICS:
 - Currently in use for seismology and geology research.
 - Current depth of seismic station is 90m.
 - Local geology granite.
 - Local population density 294/km² (Baden-Wurtemberg 35.75km²)
 - Distance to sea or ocean is approximately 300km.
- SITE MEASUREMENTS:
MID 2010

CANDIDATE SITES

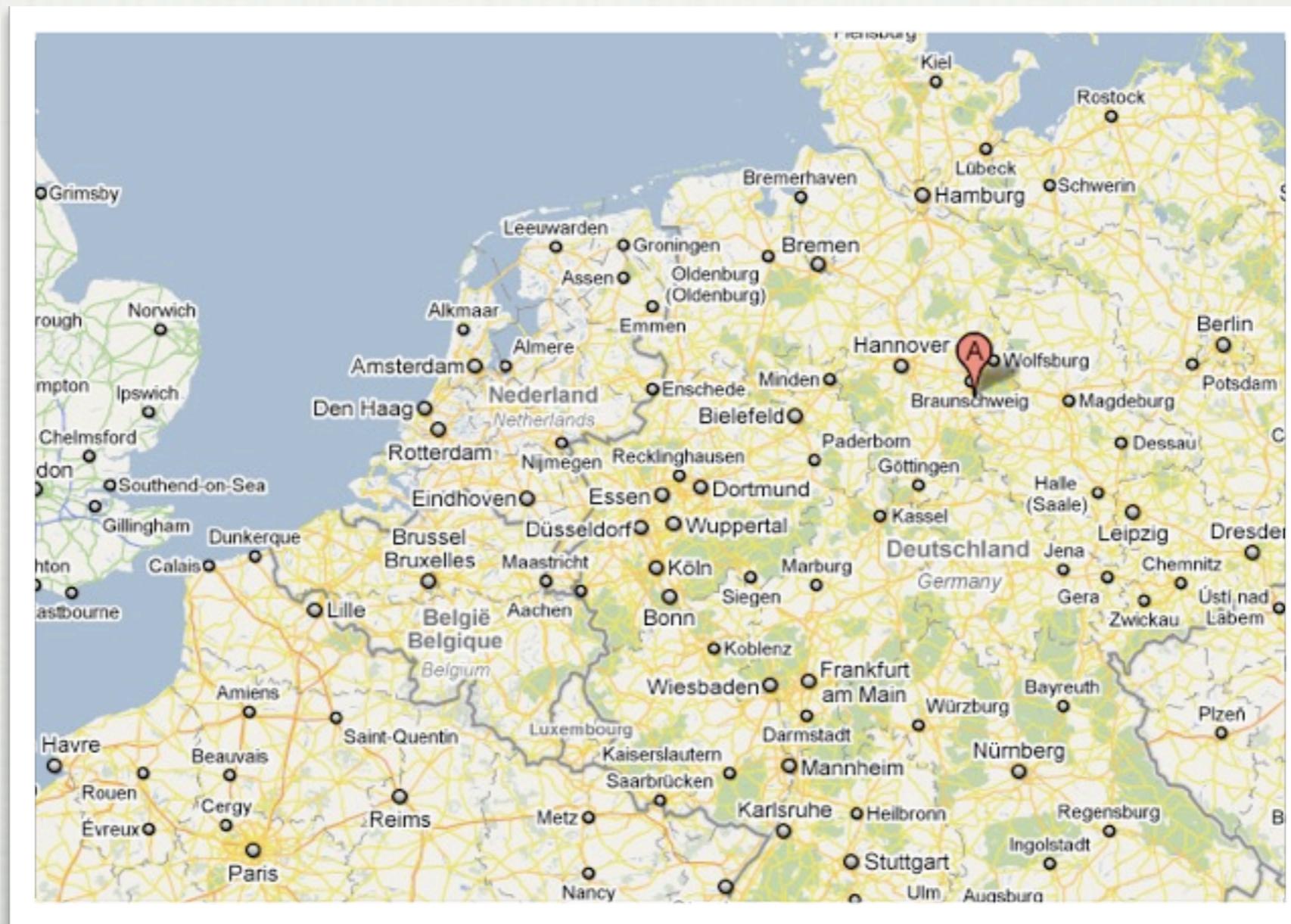


CANDIDATE SITES



CANDIDATE SITES

- GERMANY:
ASSE SALT MINE



CANDIDATE SITES

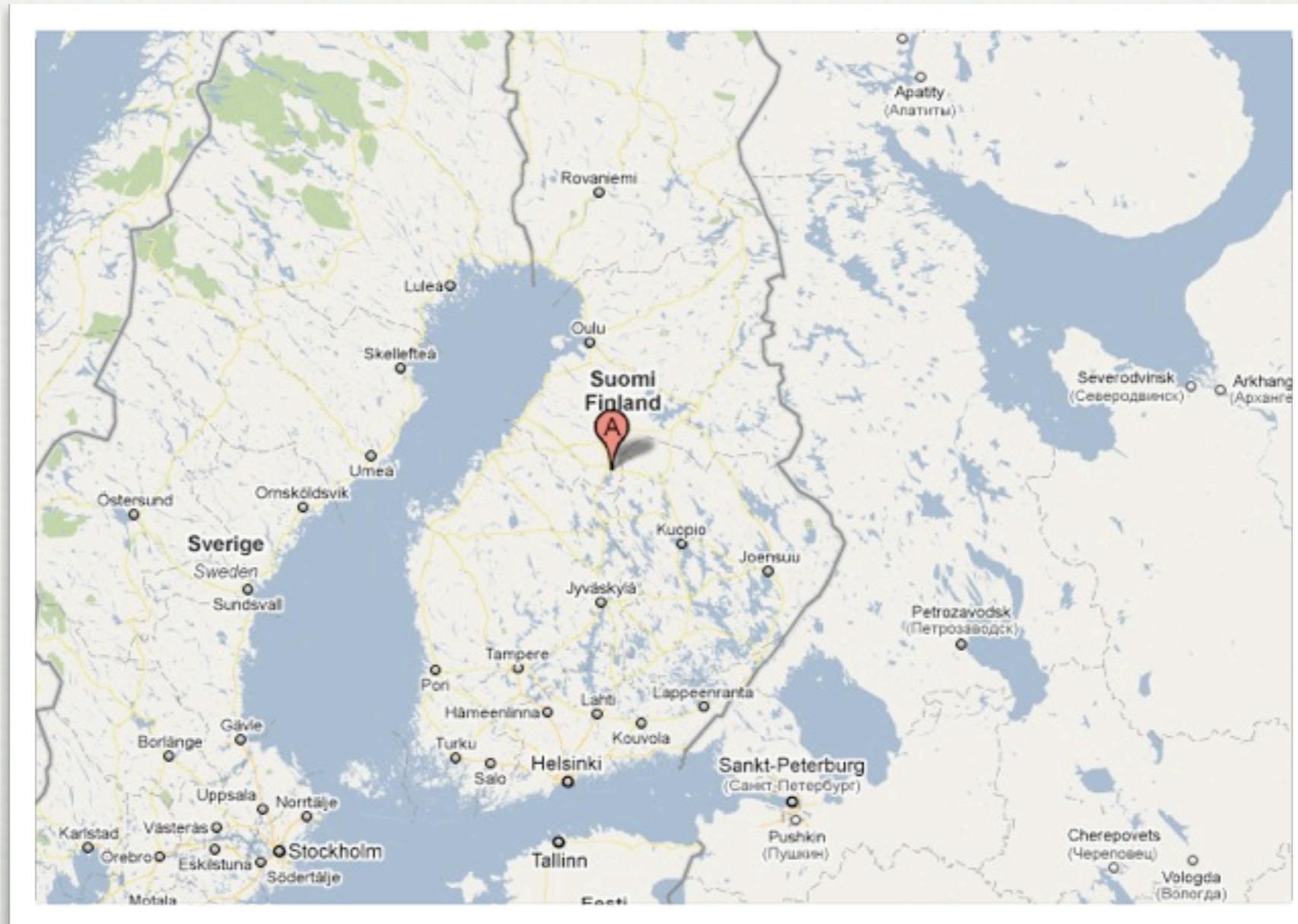


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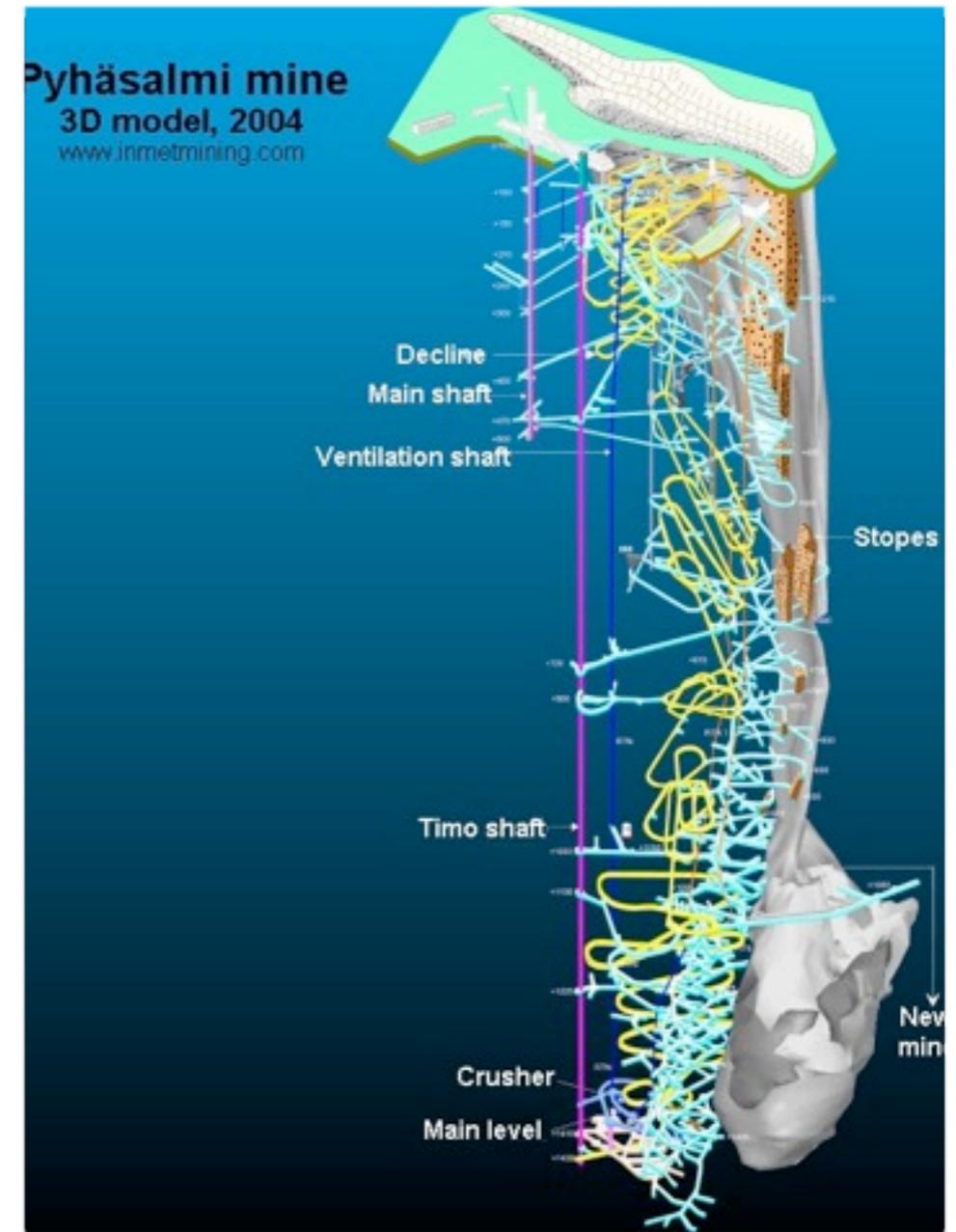
- GERMANY:
ASSE SALT MINE
- SITE CHARACTERISTICS:
 - Operational salt mine (and to store nuclear waste material).
 - Requesting seismic data from the international linear collider site selection.
 - Local population density is $690/\text{km}^2$ (Wolfenbüttel 78.46km^2).
 - Distance to sea or ocean is approximately 250km.
- SITE MEASUREMENTS:
MID 2010

CANDIDATE SITES

- FINLAND:
PYHAJARVI MINE



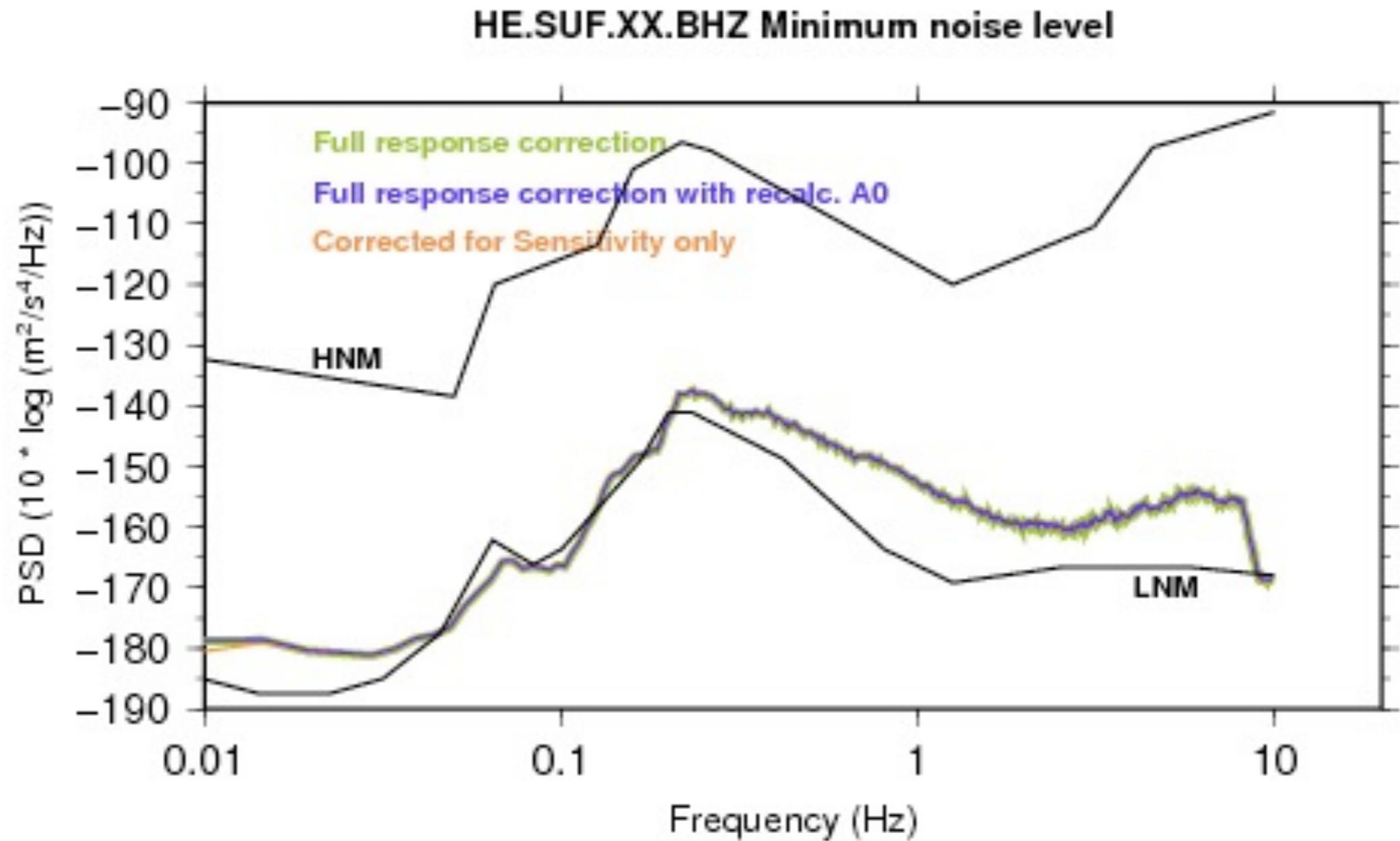
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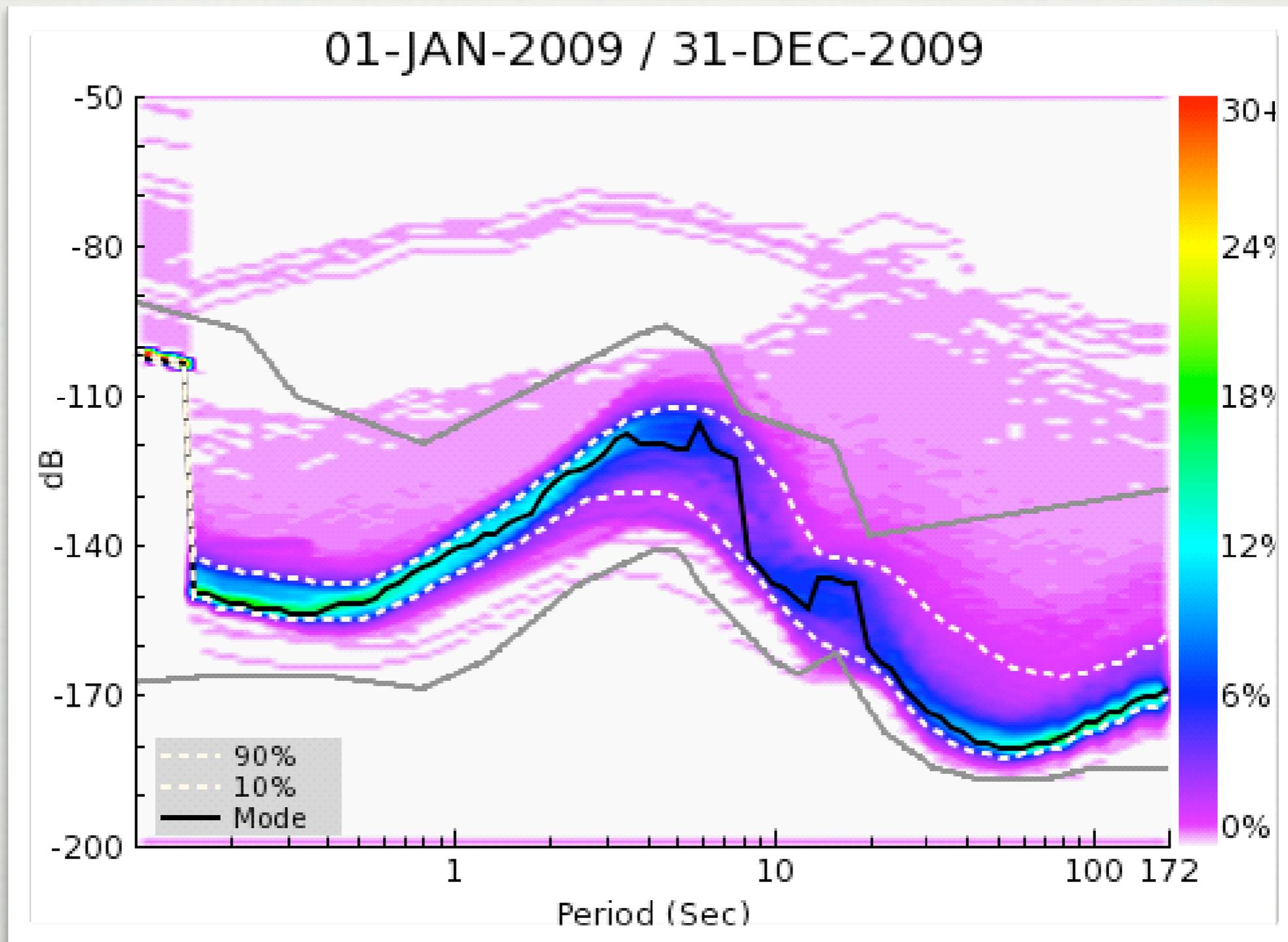
CANDIDATE SITES

- FINLAND:
PYHAJARVI MINE
- SITE CHARACTERISTICS:
 - Operational zinc and copper mine.
 - Located in Pyhäjärvi (Holy Lake), 450 km north of Helsinki and 150 km south of Oulu.
 - It is the oldest operating metal mine in Finland and the deepest in Europe, and is currently owned by Inmet Mining Corporation (Canada).
 - Hard and very old bedrock of Finland.
 - Local population density 4.58 /km²
 - Local geology is hard rock.
 - Distance from sea or oceans is approx. 150 km.
- SITE MEASUREMENTS:
MID-AUTUMN 2010

CANDIDATE SITES

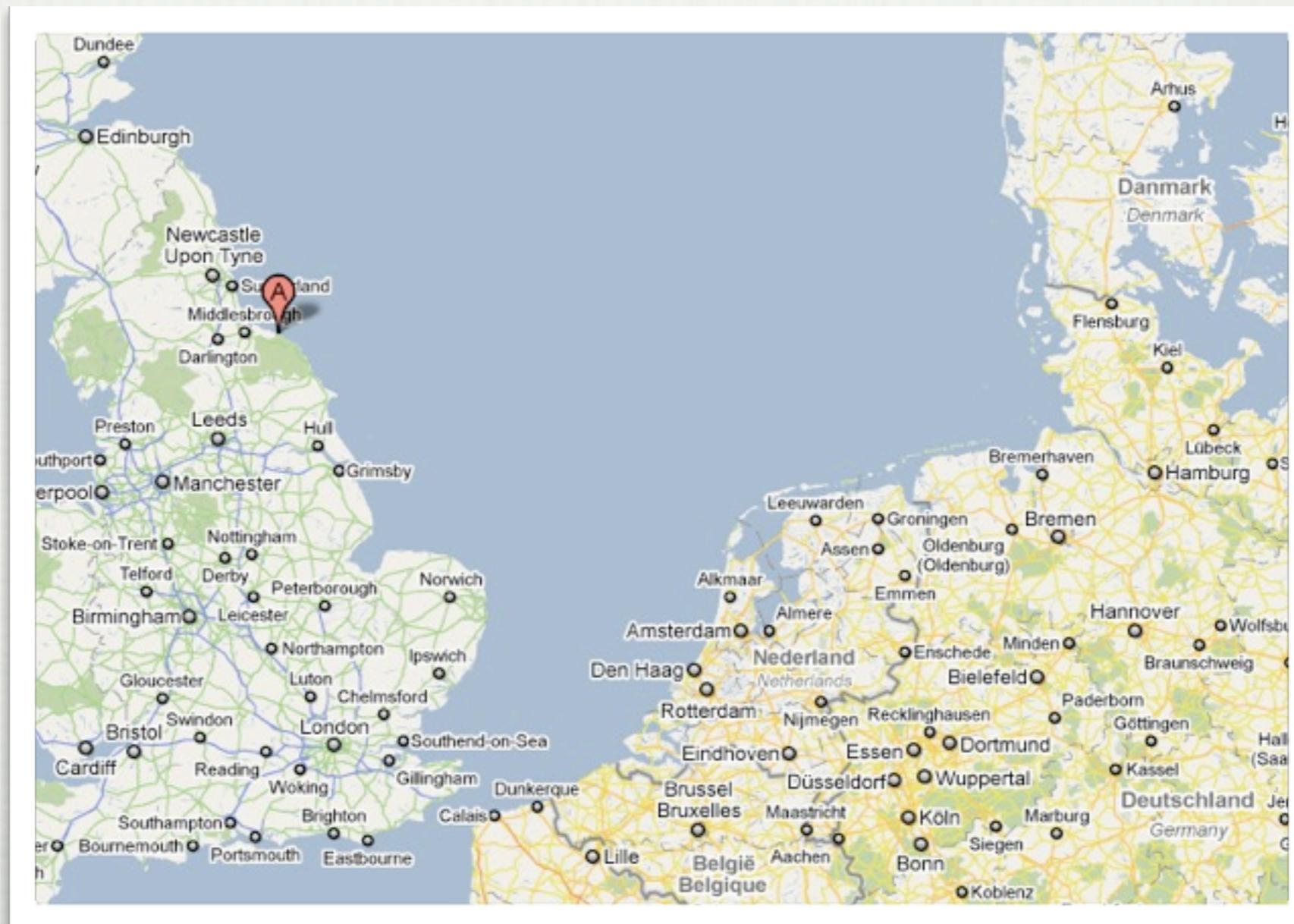


CANDIDATE SITES



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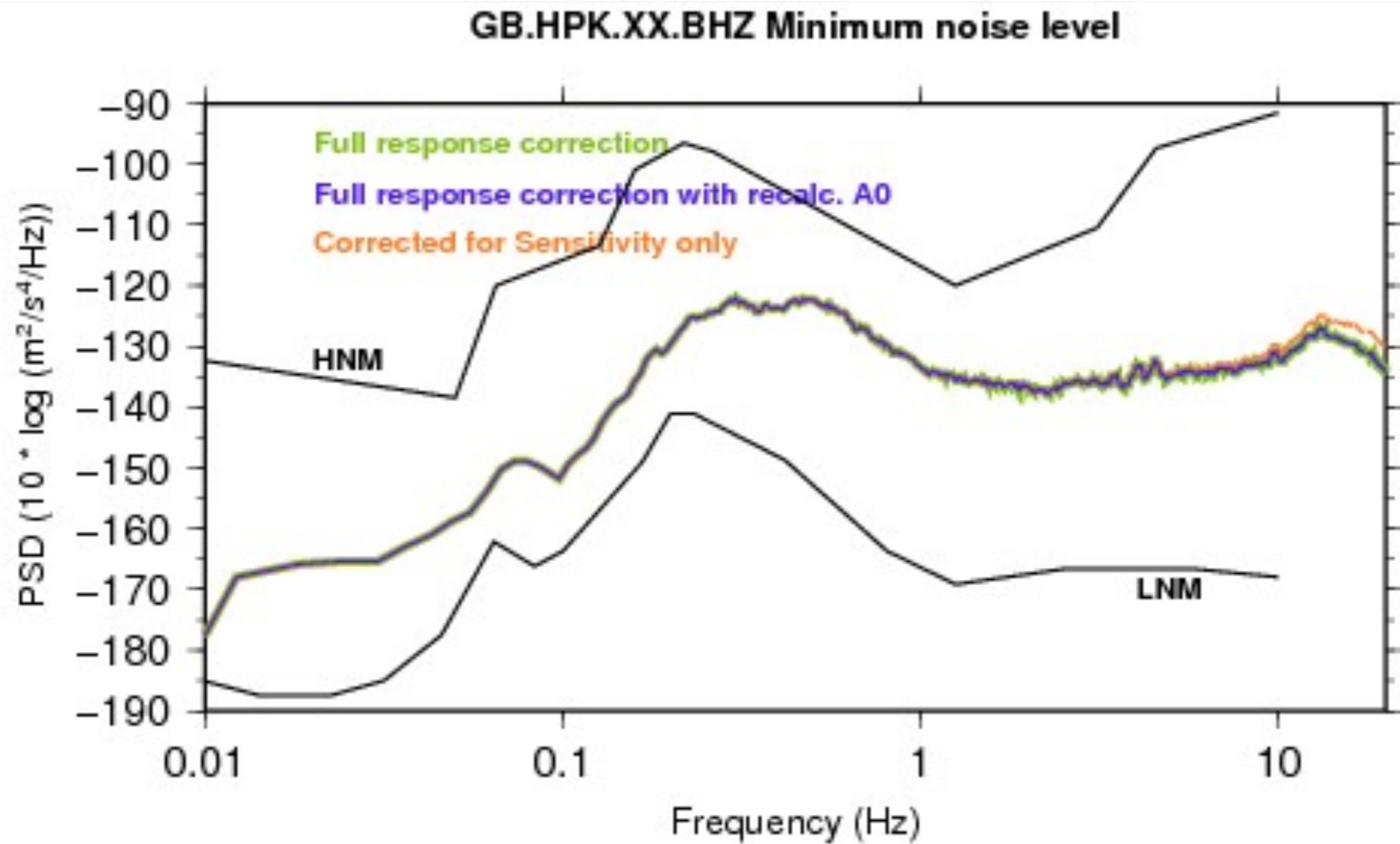
- UK:
BOULBY SALT MINE



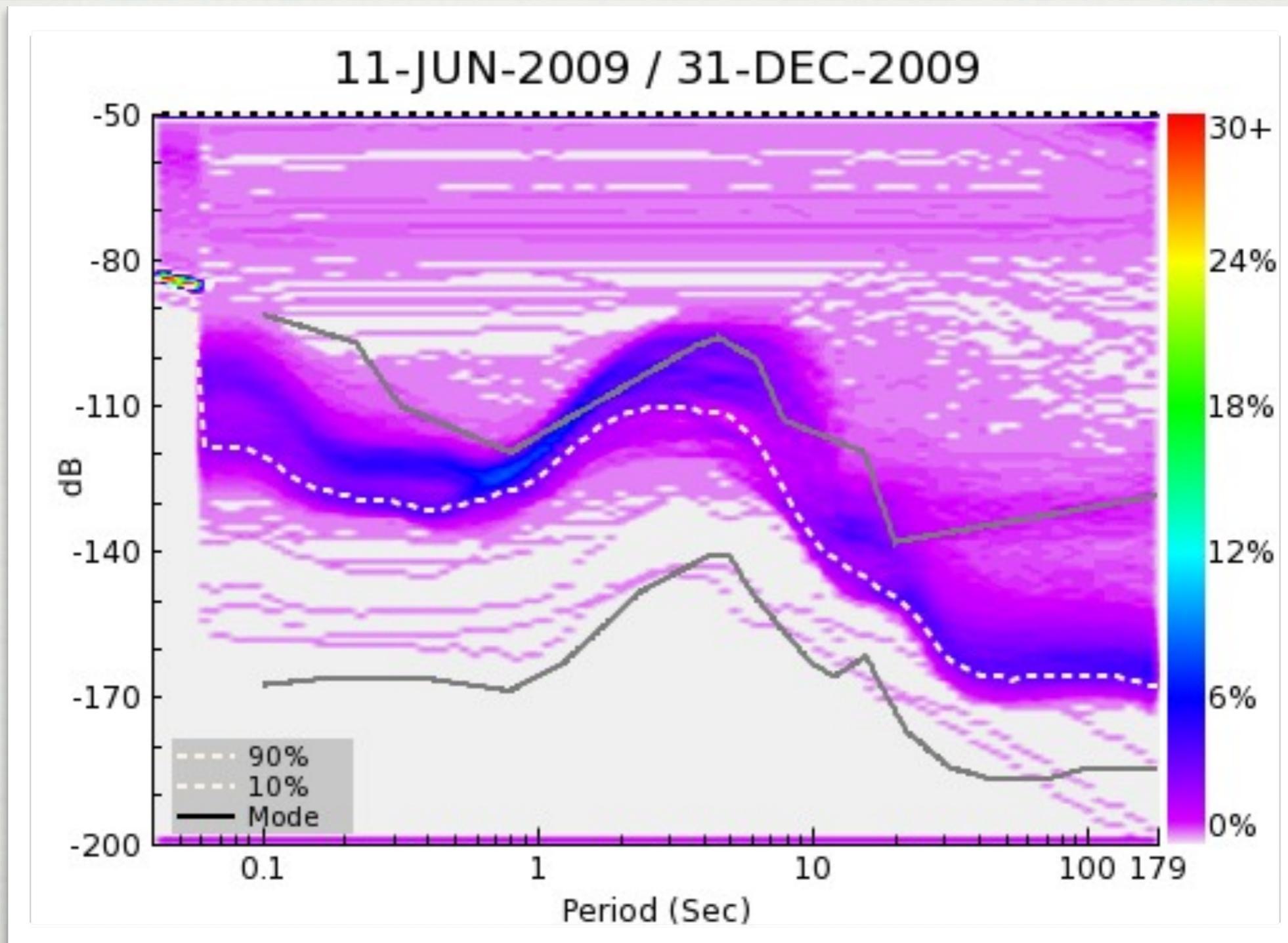
CANDIDATE SITES

- UK:
BOULBY SALT MINE
- SITE CHARACTERISTICS:
 - Operational salt mine.
 - Located in redcar and cleveland.
 - Local population density $570 / \text{km}^2$ (redcar and cleveland 244.9km^2)
 - Distance from sea or oceans is approx. 100m.
- SITE MEASUREMENTS:
MID-AUTUMN 2010

CANDIDATE SITES

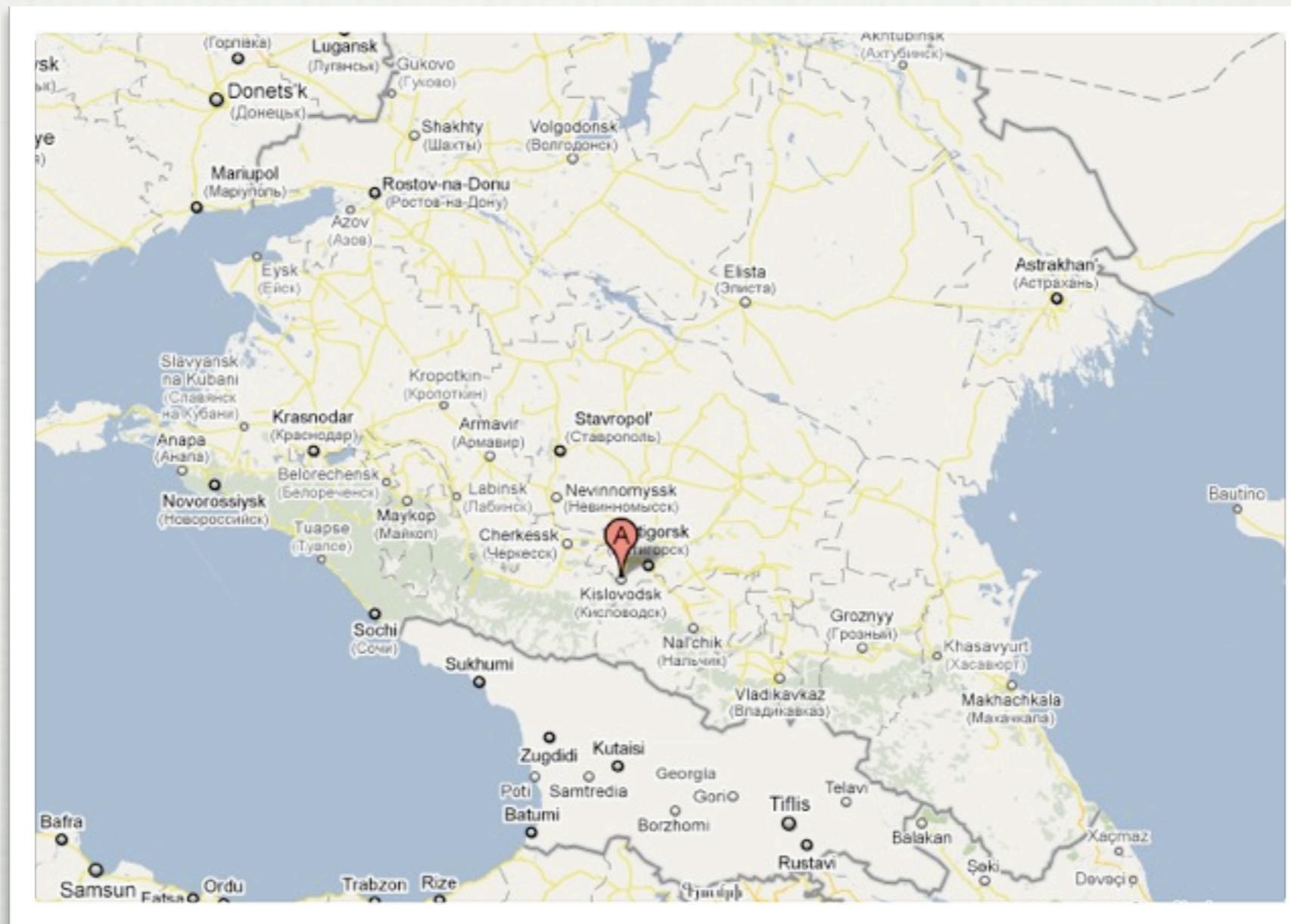


CANDIDATE SITES



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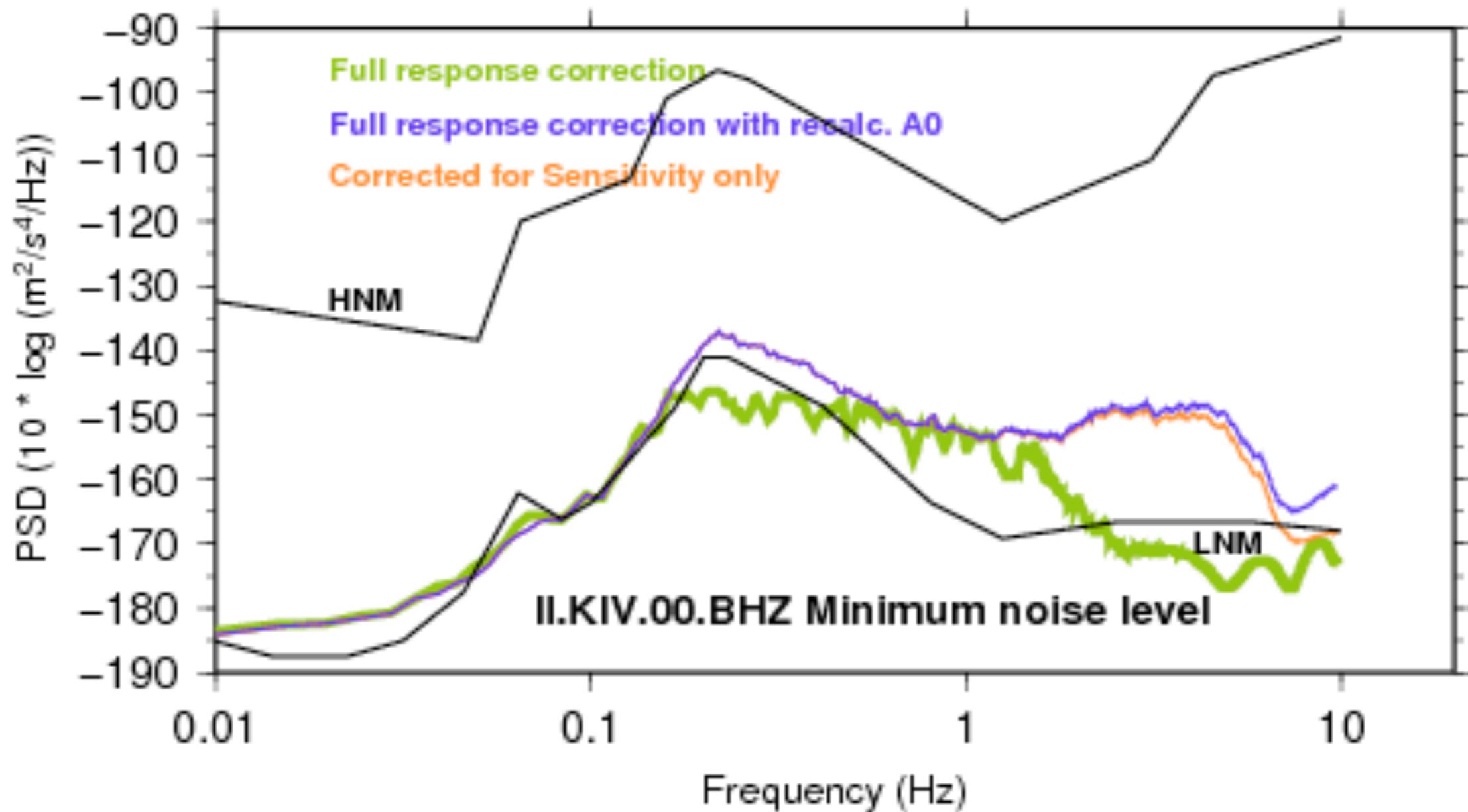
- RUSSIA:
BAKSAN NEUTRINO OBSERVATORY



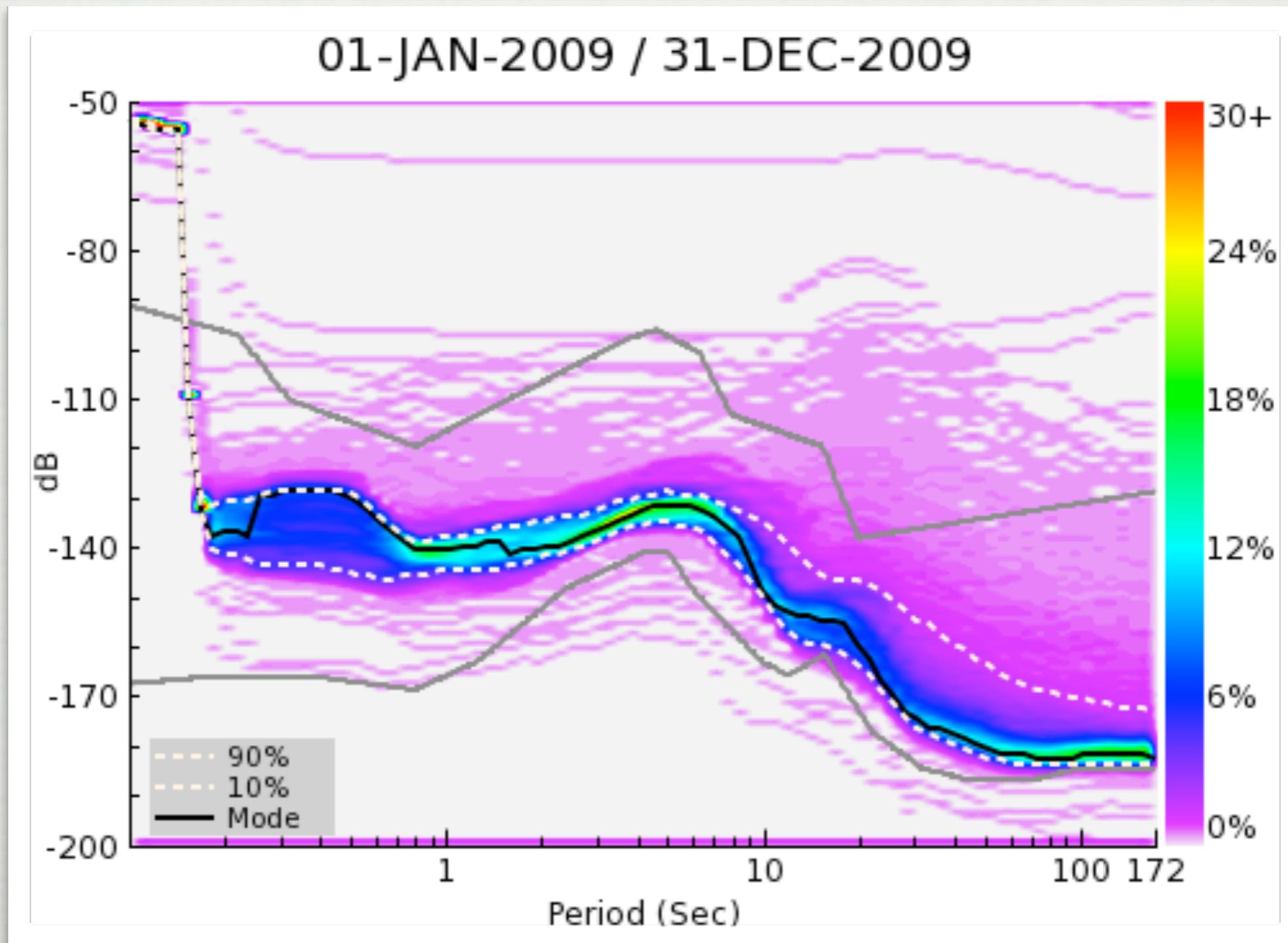
CANDIDATE SITES

- RUSSIA:
BAKSAN NEUTRINO OBSERVATORY
- SITE CHARACTERISTICS:
 - Operational neutrino observatory located in the baksan gorge in the caucasus.
 - Located 300m and 3500m below the surface.
 - Seismic stations located 50km from baksan.
 - Local population density 1.8 /km² (kislovodsk 72km²)
 - Distance from sea or oceans is approx. 200km.
- SITE MEASUREMENTS:
MID-AUTUMN 2010

CANDIDATE SITES



CANDIDATE SITES



MEASUREMENT TIMETABLE

Seismic measurements 2010				
Location	Institute/organisation	Status	Material	Remarks
Finland	Pyhajarvi (Holy lake), Inmet Mining Corporation	Visit: June 18 - 21	Hard rock	Active metal mine
France	LSM, Laboratoire Souterrain de Modane, Frejus	Visit: April 16-24, 2010	Hard rock	
Germany	Asse II	Seismic data available	Salt	Nuclear waste storage, plastic deformation
	Harz mountains		Hard rock	
	Black Forest	Seismic data available, Visit: June 1 - 7	Hard rock	Former nickel mine
Hungary	GyöngyöSOROSZI mine	Visit: April 1-6, 2010	Hard rock	
Italy	LNGS, Gran Sasso	Seismic data available	Hard rock	
	Italkali Mining Company, RealMonte	Visit: November 2009	Salt	Active salt mine
	Carbonia, Sardinia		Hard rock	Former coal mine
	Caso, Umbria		Limestone	Tunnel planned
Japan	Kamioka underground lab	Visit: May 7 - 28, 2010	Hard rock	
Netherlands	KNMI, Heimansgroeve	Visit: March 2010	Mergel	
Poland	Polkowice-Sieroszowice mine, KGHM Polska Miedz S.A.	Visit: June 9 - 15, 2010	Rock/Salt	Copper mine
Romania	Slanic-Prahova, SALROM S.A.	Visit: April 8-14, 2010	Salt	Former salt mine
Spain	Canfranc Underground Laboratory	Visit: April 26 - May 2, 2010	Soft rock	Under mountain El Tobazo, Pyrenees
Sweden				
UK	Boulby, Cleveland, Parker Underground laboratory		Salt	Active salt mine
USA	Homestake- DuseL	Installed 2 Trillium 240 in Summer 2009, continuous data taking	Hard rock	Former gold mine

CANDIDATE SITES

