EGU23-6393

Application of controlled vibration sources for traceable on-site calibration of seismometers

Christoph Pilger[1], Michaela Schwardt[1]
[1] Federal Institute for Geosciences and Natural Resources (BGR), Germany
Contact: michaela.schwardt@bgr.de

Bundesanstalt für Geowissenschaften und Rohstoffe

Introduction

We evaluated natural, anthropogenic & controlled sources of seismic waves with respect to their potential use as excitation signals for on-site calibration in the range of 0.01 to 20 Hz (Schwardt et al., 2022).

Man-made controlled sources such as hammer blows or vibrator sources exhibit interesting properties: high repeatability, broad frequency content, & applicability.

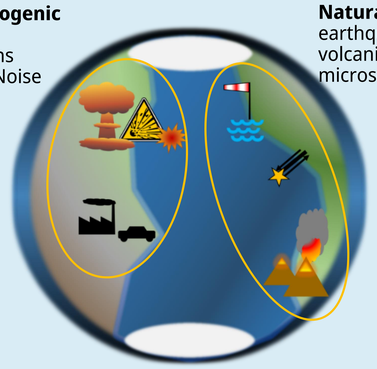
As previous on-site calibration experiments have shown, insufficient coherent natural excitation signals within the relevant high frequency range (8-20 Hz) have been recorded, leading to missing information in the frequency response estimation.

Aim

Are the controlled sources applicable in the field and able to provide the necessary information to fill the information gap?

Anthropogenic sources:
Explosions
cultural Noise

Natural sources:
earthquakes
volcanic activity
microseisms



Controlled sources:
Drop weights, hammer blows, vibration sources

The Excitation Experiment

Sources

- portable **El**ectrodynamic-**Vi**brator **S**ystem (ElViS; GEOSYM GmbH)
- vertical & horizontal hammer blows on a steel plate, the plain surface, & rocks

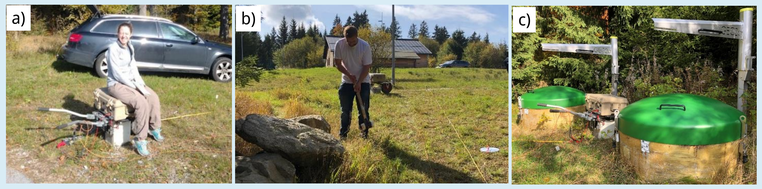


Fig. 1: Excitation sources in operation. a) portable elctrodynamic-vibrator system; b) horizontal hammer blows against rocks; c) ElViS between the vaults with the station and reference sensors.

Set-up

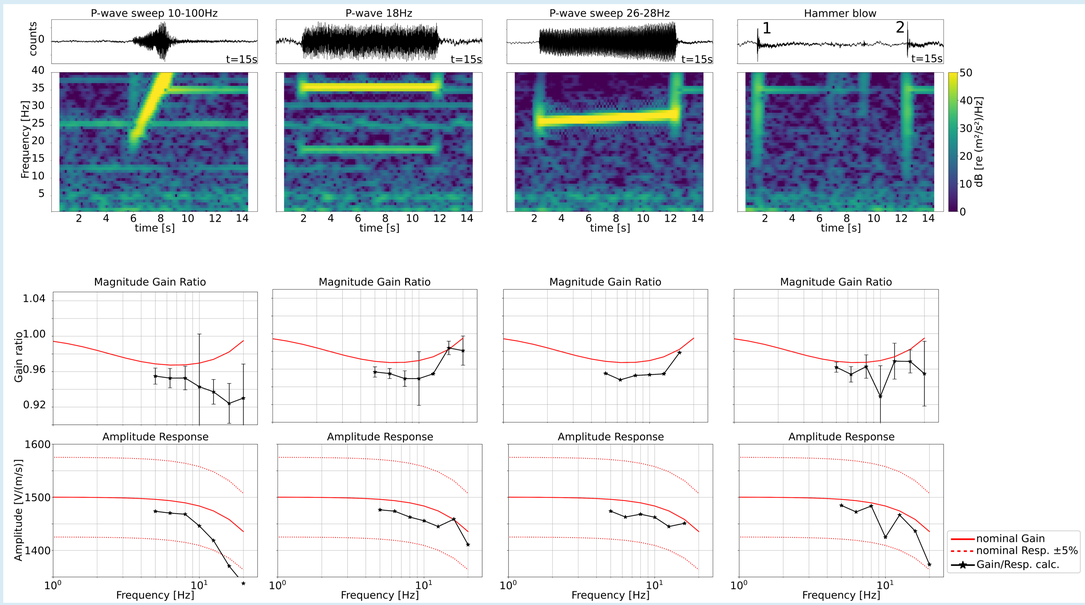
- 2 co-located seismometers in vaults within a distance of 2 m
- Reference seismometer: Streckeisen STS2.5
- seismometer under test: Guralp CMG-3T
- Variation of source distance to seismometer (1-75 m) & direction of signal arrival
- Excitation of single frequency (18 Hz) or different sweep signals (26-28 Hz; 10-100 Hz) of 10 s length in either P- or S-wave configuration

Methodology

Calculation of the frequency response function of the station sensor using a traceable calibrated reference instrument by comparison and determination of a gain ratio between the sensors in the frequency domain for the excited signals

Poster EGU23-11059/X4.64

Results



Evaluation for vertical component (highly sensitive to excited P-wave signals):
→ the frequency response can be determined for the higher frequencies of interest (5-20 Hz) using the different excitation signals

Additional Benefits

- Signals within the needed frequency range can be excited - speeds up the calibration process
- Determination of seismometer orientation/azimuth between reference & station sensors – orientation of reference sensor can be corrected on-site

Open Points

- Phase response needs to be determined
- Determination of frequency response function for horizontal components with excited S-wave signals

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

References

Schwardt, M., Pilger, C., Gaebler, P., Hupe, P., & Ceranna, L. (2022). Natural and Anthropogenic Sources of Seismic, Hydroacoustic, and Infrasonic Waves: Waveforms and Spectral Characteristics (and Their Applicability for Sensor Calibration). Surveys in Geophysics, 43(5), 1265-1361.