Geophysical Research Abstracts
Vol. 20, EGU2018-10539-1, 2018
EGU General Assembly 2018

Bedrock morphology modelling using geologically-dependant empirical equations between resonance frequency and bedrock depth

Koen Van Noten (1), Xavier Devleeschouwer (1), Celine Goffin (1), Bruno Meyvis (1), and Thomas Lecocq (2)
(1) Geological Survey of Belgium, Royal Belgian Institute of Natural Sciences, Brussels, Belgium (koen.vannoten@naturalsciences.be), (2) Seismology-Gravimetry, Royal Observatory of Belgium, Brussels, Belgium

Calculating thickness variations of soft sediments above bedrock is important for site effect characterisation, earthquake ground motion amplification and for hydrogeological and geothermal purposes. In case seismic array instrumentation is not available and hence shear-wave velocity profiles cannot be obtained, other correlation techniques need to be applied to accurately deduce bedrock depth.

Nakamura's H/V Spectral Ratio (HVSR) analysis of ambient noise is a powerful seismological method to reveal a site's resonance frequency. The conversion from a resonance map to a bedrock depth map in areas with a different sedimentary cover in terms of layer thickness and lithologies is, however, not straightforward. Converting resonance frequencies to depth by applying a mean shear-wave velocity (Vs) will under- and overestimate bedrock depth at higher and lower topographies, respectively. Applying an empirical log-log (powerlaw) relationship between resonance frequency (obtained from HVSR analyses) and bedrock depth (obtained from boreholes) provides a much better depth estimation that considers the non-linear increase of Vs with depth. Accurate empirical equations can however only be constructed from HVSR measurements performed in areas with similar lithological sediments.

In this study we present a high-resolution microzonation study performed in Brussels (Belgium) where both the sedimentary cover and the fractured top of the bedrock (i.e. the Brabant Massif) are of interest for their geothermal potential. Using 88 ambient noise measurements above boreholes we constructed four different powerlaw equations that are applicable to convert resonance frequency to depth in areas with a clayey, sandy-clayey, alluvial-clayey and alluvial sedimentary cover. Subsequently, 405 ambient noise measurements were conducted and converted to virtual boreholes using these four empirical equations. Measurements were used to map out bedrock depth in a 15 km^2 and a 25 km^2 area applying a 200 m and 500 m station density spacing, respectively. The results demonstrate the presence of NW-SE oriented, 20 m-high ridges at 100 m depth that stand out because of differential erosion between less-resistant slaty (Tubize Formation) and hard quartzitic (Blanmont Formation) rock formations of the Brabant Massif.

Separating seismic data according to their subsurface geology results in more accurate empirical frequency-depth conversion equations than if only one equation would be used for an entire area.