Geophysical Research Abstracts
Vol. 21, EGU2019-11898, 2019
EGU General Assembly 2019

Passive Imaging of Active Source Data: Seismic Ambient Noise Interferometry in a Mining Environment

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Active source acquisition with cable-free systems ('nodes') implies recording of continuous data over the entire acquisition period (e.g. days to months). Due to the lack of well-defined seismic sources, data outside the shot windows are usually not considered for processing and interpretation, despite the potential useful information contained in the continuous data. Ambient seismic noise interferometry is a suitable method to extract complementary subsurface information from other sources of abundant environmental seismic energy such as road traffic. We present a case study from the ore quarry 'Erzberg' located in central Austria. Seismic investigation of this area aims at characterizing the site response to blasting and subsequently, to optimize the mining process. Furthermore, the subsurface distribution of potential new ore veins is of interest.

In November 2016, 125 3C – stations where deployed for three weeks to record both production blasts and specifically designed seismic shots. The acquisition area is 2.5 km by 2.0 km wide and covers both the active mine and its surroundings. The active source data have been processed towards a 3D P-wave velocity model with average velocities ranging from ca. 4 km/s to 5 km/s.

Beamforming analysis of the continuous passive data indicate a dominant noise source outside and towards the east of the deployment area. Coherent signals are found in the frequency band 1 Hz to 6 Hz, which is in agreement with the assumption of traffic noise originating from a nearby state road. Ambient noise interferometry is performed by converting each of the recording stations into a virtual source. The resulting virtual source gathers show clear Rayleigh and Love waves on the vertical and transverse components. The moveout of the arrivals indicate apparent surface wave velocities between 1.7 km/s and 1.9 km/s, which would suggest P/S wave velocity ratios in the range of 2 – 2.5. The inversion of surface wave dispersion for a 3D shear-wave velocity model will allow to extract localized P/S ratios and as such contribute to the seismic site characterization.

We conclude that active source data acquisition with nodes offers complementary information at negligible additional costs. Traffic noise from a few weeks or even days is sufficient to generate shear wave velocity models, which can be combined with results from active source processing and in turn benefit the interpretation.