Geophysical Research Abstracts
Vol. 15, EGU2013-7576, 2013
EGU General Assembly 2013

Investigations of Periodic Disturbances on Seismic Aftershock Recordings

Mattes Liebsch, Felix Gorschlüter, Jan-Frederik Knoop, and Jürgen Altmann
Experimentelle Physik III, Technische Universität Dortmund, Germany

The Comprehensive Nuclear Test-Ban Treaty Organisation (CTBTO) runs the International Monitoring System (IMS) to detect possible violations of the treaty. The seismic sensors of the IMS are set up to detect every underground explosion with a yield of 1 kT TNT equivalent or even better everywhere on the world. Under consideration of all IMS data the hypocentre of a large underground explosion is located within an area of about 1000 sq km. To verify if it was a violation of the Test-Ban Treaty the CTBTO (after CTBT entry into force) is allowed to carry out an on-site inspection (OSI) in the area of suspicion. During an OSI the hypocentre is to be located much more precisely; for this a local seismic aftershock monitoring system (SAMS) can be installed to detect small seismic events caused as a consequence of the explosion, such as relaxation of the rock around the cavity. However the magnitude of these aftershock signals is extremely weak. Other difficulties arise from other seismic signals in the inspection area, for example caused by vehicles of the inspectors, from coupling of airborne signals to the ground, or even by intended attempts to disturb the OSI.

While the aftershock signals have a pulsed shape, man-made seismic signals (primarily created by engines) usually show periodic characteristics and thus are representable as a sum of sine functions and their harmonics. A mathematical expression for the Hann-windowed discrete Fourier transform of the underlying sine is used to characterise every such disturbance by the amplitude, frequency and phase. The contributions of these sines are computed and subtracted from the complex spectrum sequentially. Synthetic sines superposed to real signals, orders of magnitude stronger than the latter, can be removed successfully. Removal of periodic content from the signals of a helicopter overflight reduces the amplitude by a factor 3.3 when the frequencies are approximately constant.

To reduce or prevent disturbing seismic signals created by coupling of acoustic waves to the ground in the first place a better understanding of the acoustic-seismic coupling is required. Several acoustic and seismic measurements of periodic signals (e.g. helicopters) and pulse-shaped signals (fire crackers, hammer blows) were analysed. The data were evaluated with respect to the distance between event and sensor, the elevation angle of the signal and the burying depth of the seismic sensors. From the correlation of acoustic and seismic spectral peaks the ratio of their spectral amplitudes can be calculated which gives the frequency dependent coupling coefficient. In the ongoing analysis the influence of constructive interference of surface waves, created by acoustic-seismic coupling at different positions in the vicinity of the sensor, is of special interest. Several recommendations for an OSI were developed with respect to sensor placement and flight trajectory of helicopters.