Geophysical Research Abstracts
Vol. 21, EGU2019-7117-2, 2019
EGU General Assembly 2019

Automatic full waveform-based monitoring of induced microseismicity at Garpenberg mine, Sweden

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Multiple studies have demonstrated the efficiency of automatic full waveform-based detection and localization approaches. Application of these techniques has shown significant improvement in detection capacity compared to the triggered-based system. The increased number of detected events allows to perform detailed statistical analysis of seismicity in space and time (i.e. b-value of the Gutenberg Richter law, p-exponent of the Omori law and gamma value of the inter-event times). This may permit identification of potential nucleation phases of large events using dense space-time event clusters which can provide information about stress transfer and dynamic rupture characteristics. However, real-time automatic monitoring of microseismicity in mining application is non-trivial. The two main challenges to be considered here are: high sampling rate of recorded seismic data ($\sim$ kHz) and a wide range of microseismic sources (i.e. machine noise, blasts, induced seismicity).

In this study, we propose an automatic full waveform-based microseismic event detection and location workflow for near-real-time seismic monitoring. We implemented and test the method on a study case of deep metal mine ($>$ 1km in depth) at Lappberget district of the Garpenberg mine, Sweden. The proposed method consists of two steps: event extraction and preliminary location (step 1) and relocation (step 2). Step 1 is based on multiband frequency detection and first-order amplitude ratio location. Whereas, step 2 uses backprojection technique (BacktrackBB) estimating a better constrained space-time location of hypocenters. Step 1 targets reduction of transferred 8 kHz sampled seismic data ($\sim$ 60GB per day) and provides an energy-ratio-based classification of events that allows to remove machinery noise detections. We estimated that detection capacity compared to conventional triggering-based monitoring system is improved by at least a factor of 50. This increased number of detected events permits to investigate migration pattern of microseismic activity in response to production blast. The method has been implemented in a local seismic monitoring system of Ineris (France) and is consistently improved to ensure a reliable real-time detection and location.