Full waveform-based automatic monitoring of microseismic activity using high sampling rate records: application to Garpenberg mine (Sweden)

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Recent studies demonstrated success of automatic full waveform detection and location methods in analyzing and monitoring natural and induced seismicity. These approaches provided a significant improvement in events detectability increasing the significance of statistical analysis permitting to identify small changes of seismicity rates in space and time. It is expected that application of full waveform-based method to seismic monitoring of active mines could significantly improve forecasting of potential destructive rock-burst events. However, such implementations are currently non-trivial and by far nonstandard. Main challenges here come from the presence of a wide range of seismic sources related to mining activity and a high sampling rates of recorded data (~ kHz) posing problems for real-time data transfer and processing.

We present an adapted, full waveform-based automatic method for detection and location of microseismic events that makes use of continuous seismic records from an in-mine seismic network. The method can be adjusted to a real-time monitoring scheme and consists of two steps: event extraction and amplitude ratio-base preliminary location; and event relocation using coherency-based backprojection approach. The event extraction based on multi-band 2-D signal characterization allows to overcome the challenge of high sampling rate data (8 kHz), reducing the overall volume of transferred data and providing an energy-based signal classification scheme for removing signals from machinery noise sources. The technique is developed and tested on the case study of Garpenberg mine (Sweden) monitored by a high-resolution permanent local seismic network maintained by Ineris. We demonstrate the improvement in event detection capacity offered by our method in comparison to the standard triggered-based monitoring schemes and discuss how the increased number of detected microseismic events permits to better characterize the response of the mine to production activity.

Keywords: full waveform methods, mining induced seismicity, automatic monitoring, continuous data analysis

