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Monitoring Induced Seismicity with AE Sensors : The Influence of Unknown Calibration Functions

Katrin Plenkers (1), Grzegorz Kwiatek (2), and Frank Krüger (3)

(1) ETH Zurich, Swiss Seismological Service, Zurich, Switzerland (katrin.plenkers@sed.ethz.ch), (2) GFZ Potsdam, Potsdam, Germany, (3) University Potsdam, Potsdam, Germany

We study the effect that an uncalibrated acoustic-emission (AE) sensor has on amplitude and magnitude using data of the JAGUARS project. The JAGUARS project recorded mining-induced seismicity in Mponeng Gold mine in Carletonville, South Africa in the frequency range 1 kHz < f < 180 kHz combining AE-sensors and accelerometers.

Advanced monitoring of induced seismicity in underground structures sometimes includes today the use of high-frequency (f » 1 kHz) AE monitoring systems. High-frequency monitoring allows the detection of seismic fractures on the centimeter scale and provides therefore important information about the migration of instabilities in the rock.

Whereas the temporal-spatial analysis of seismic events recorded with AE sensors provides stable results, the analysis of source parameters including the estimation of magnitudes remains more challenging, because AE sensors are normally not well calibrated and exploit resonance frequencies to allow for high sensitivity.

In our study the AE sensors are first calibrated in the frequency range 1kHz to 17 kHz relative to the well calibrated accelerometer. The calibration is possible due to the close employment of both sensor types, which allows to extract the sensor response (including the coupling effect) using signal deconvolution. We estimate three main resonance frequencies at about 2.5 kHz, 6 kHz and 10 kHz. Furthermore we calculate the directivity effect of the AE-sensor that influences the amplitude of the signal by up to - 15 dB.

Second, we calculate the effect of the instrument response on the amplitude and the calculation of magnitude by studying synthetic data. We show the significant uncertainty that is introduced owing to the AE sensor response and conclude that source parameters often have high uncertainties and are not reliable for statistcal analsis if the instrument response of the recording AE sensor is not known.