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Coda-Based Estimation of Source Parameters of Laboratory Acoustic-Emission Events

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We propose a coda-based estimation of source parameters of acoustic events recorded in laboratory experiments on rock deformation. Coda-waves are considered as the reverberation of the acoustic field in the tested sample. After multiple reverberations, the resulting wavefield can be approximated as nearly homogeneously distributed over the sample and with signal amplitudes decaying exponentially in time (linearly in a logarithmic scale). Within the framework of this model, the frequency-dependent coda amplitude at any moment of time is described as combination of a source spectra, of a decay rate combining internal attenuation with reverberation losses, and of a sensor response. One of the main difficulties with the laboratory experiments is that acoustic sensors are very difficult to calibrate and their absolute response function in most of cases remains unknown. With the simple reverberation model, the logarithms of coda amplitudes at different times and sensors and for multiple events are described by a system of linear equations that we solve in a least-square sense to find frequency-dependent decay rates and relative source spectra and sensor responses. In a next step, we compute spectral ratios between different events to eliminate the sensor responses and to estimate main source parameters such as corner frequencies and relative seismic moments. Additionally, we propose a new method for computing relative magnitudes (energy classes) of acoustic emission events from the coda envelopes and argue that it might be more robust comparing with estimations based on first arrivals.

We provide details of our data analyses tehnique and present first results of our new coda-based method applied to 30-600 kHz signals recorded during experiments carried out in the Research Equipment Sharing Center of IPE RAS “Petrophysics, Geomechanics and Paleomagnetism” on a controlled hydraulic press INOVA-1000 of the Geophysical Observatory ”Borok”, IPE RAS with granites of the Voronezh massif and Berea sandstones.

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