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Combining double difference and amplitude ratio approaches for Q estimates at the NW Bohemia earthquake swarm region

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Aside from the propagation velocity of seismic waves, their attenuation can provide a direct measure of rock properties in the sampled subspace. We present a new attenuation tomography approach exploiting relative amplitude spectral ratios of earthquake pairs. We focus our investigation on North West Bohemia – a region characterized by intense earthquake swarm activity in a confined source region. The inter-event distances are small compared to the epicentral distances to the receivers meeting a fundamental requirement of the method. Due to the similar event locations also the ray paths are very similar. Consequently, the relative spectral ratio is affected mostly by rock properties along the path of the vector distance and thus representative of the focal region. In order to exclude effects of the seismic source spectra, only the high frequency content beyond the corner frequency is taken into consideration. This requires high quality as well as high sampling records. Future improvements in that respect can be expected from the ICDP proposal “Eger rift”, which includes plans to install borehole monitoring in the investigated region.

1D and 3D synthetic tests show the feasibility of the presented method. Furthermore, we demonstrate influences of perturbations in source locations and travel time estimates on the determination of Q. Errors in Q scale linearly with errors in the differential travel times. These sources of errors can be attributed to the complex velocity structure of the investigated region. A critical aspect is the signal-to-noise ratio, which imposes a strong limitation and emphasizes the demand for high quality recordings. Hence, the presented method is expected to benefit from bore hole installations.
Since we focus our analysis on the NW Bohemia case study example, a synthetic earthquake catalog incorporating source characteristics deduced from preceding moment tensor inversions coupled with a realistic velocity model provides us with a realistic testing dataset of synthetic waveforms.

Application to recordings from the WEBNET (West Bohemia Seismic Network) benefit from the density of the cluster of seismicity. This allows a high rate of repetitive samplings of the source region and therefore mitigates the sensitivity on signal-to-noise ratio.

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