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Measurements of frequency dependent shear wave attenuation in sedimentary basins using induced earthquakes

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Modeling of peak ground velocity caused by induced earthquakes requires detailed knowledge about seismic attenuation properties of the subsurface. Especially shear wave attenuation is important, because shear waves usually show the largest amplitude in high frequency seismograms.

We report intrinsic and scattering attenuation coefficients of shear waves near three geothermal reservoirs in Germany for frequencies between 2 Hz and 50 Hz. The geothermal plants are located in the sedimentary basins of the upper Rhine graben (Insheim and Landau) and the Molasse basin (Unterhaching). The method optimizes the fit between Green's functions for the acoustic, isotropic radiative transfer theory and observed energy densities of induced earthquakes. The inversion allows the determination of scattering and intrinsic attenuation, site corrections, and spectral source energies for the investigated frequency bands.

We performed the inversion at the three sites for events with a magnitude between 0.7 and 2. We determined a transport mean free path of 70 km for Unterhaching. For Landau and Insheim the transport mean free path depends on frequency. It ranges from 2 km (at 2 Hz) to 30 km (at 40 Hz) for Landau and from 9 km to 50 km for Insheim. The quality factor for intrinsic attenuation is constant for frequencies smaller than 10 Hz at all three sites. It is around 100 for Unterhaching and 200 for Landau and Insheim with higher values above 10 Hz.