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Seismic attenuation in West Bohemia earthquake swarm region obtained by coda waves analysis

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Seismic waves are attenuated by number of factors, including geometrical spreading, scattering on heterogeneities and intrinsic loss due the anelasticity of medium. Contribution of the latter two processes can be derived from the tail part of the seismogram – coda (strictly speaking S-wave coda), as these factors influence the shape and amplitudes of coda (e.g. Aki and Chouet, 1975; Sato and Fehler, 2009).

Numerous methods have been developed for estimation of attenuation properties from the decay rate of coda amplitudes (e.g. Aki and Chouet, 1975; Fehler et al., 1991). Most of them work with the S-wave coda, some are designed for the P-wave coda (only of teleseismic distances) or for the whole waveforms. We used methods to estimate the 1/Qc - attenuation of coda waves, methods to separate scattering and intrinsic loss – 1/Qsc, Qi and methods to estimate attenuation of direct P and S wave – 1/Qp, 1/Qs.

In this study, we analyzed the S-wave coda of local earthquake data recorded in the West Bohemia/Vogtland area. This region is well known thanks to the repeated occurrence of earthquake swarms. We worked with data from the 2011 earthquake swarm, which started late August and lasted with decreasing intensity for another 4 months.

During the first week of swarm thousands of events were detected with maximum magnitudes ML = 3.6. Amount of high quality data (including continuous datasets and catalogues with an abundance of well-located events) is available due to installation of WEBNET seismic network (13 permanent and 9 temporary stations) monitoring seismic activity in the area. We added data from 4 SXNET stations(in Germany) to increase the range of hypocentral distances, what enables us to use more advanced analysis methods.

Results of the single-scattering model show seismic attenuations decreasing with frequency, what is in agreement with observations worldwide. We also found decrease of attenuation with increasing hypocentral distance and increasing lapse time, which was interpreted as a decrease of attenuation with depth (coda waves on later lapse times are generated in bigger depths – in our case in upper lithosphere, where attenuations are small). We also noticed a decrease of frequency dependence of 1/Qc with depth, where 1/Qc seems to be frequency independent in depth range of upper lithosphere. Lateral changes of 1/Qc were also reported – it decreases in the south-west direction from the Novy Kostel focal zone, where the attenuation is the highest. Results from more advanced methods that allow for separation of scattering and intrinsic loss show that scattering dominates attenuation. Coda 1/Qc values and its frequency dependence is very similar to 1/Qi. We were also analyzing the accuracy of model fit to our data. It was found, that our models have best fit with data on higher frequencies – 9, 12, 18, 24 Hz, which indicates homogeneous distribution of heterogeneities with smaller dimensions.

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