Abstract

The Structure of the West Bohemian Earthquake Swarm Source Zone

Martin Bachura

Institute of Hydrogeology, Engineering Geology and Applied Geophysics
Faculty of Science, Charles University

We analyzed crustal characteristics of Earth's crust under West Bohemia earthquake swarm region from three different optics. Seismic episodes from 2008, 2011 and 2014 were subjects of relocating using double-difference *HypoDD* technique supplemented with cross-correlated input data. used data processing was proved to be efficient and produced highly precise relative locations of swarm earthquakes distributed on a single fault plane. Results were suitable for statistical and detailed spatio-temporal analyses. Moreover, used procedure was applicable even to a data achieved fully automatically (catalogs, picks) with lower initial quality. In that case the relocations are sufficiently good as a tool for mapping underground structures. On the other hand, resulting completeness and locations of stronger events might be biased as a result of sparse data (picks and differential times) and magnitude differences.

Attenuation properties of the crust were derived from coda of 30 earthquakes from 2008, 2011 and 2014 activity. Reliable frequency dependent quality factors were estimated for coda decay - Q_c, intrinsic loss and scattering - Q_i and Q_{sc} using coda window method and multiple lapse time window analysis. Less reliable results were achieved by coda normalization method for P- and S-waves - Q_P, Q_S. According to obtained results it might be conclude that attenuation is rather low (quality factors up to first thousands) and intrinsic loss is dominant attenuation process afflicting the propagation of seismic waves. We tried to explain alway unclear frequency dependent of intrinsic loss quality factor Q_i as a result of diffusive energy leak towards Earth's mantle. If so, then the magnitude of such a leakage enhances the Q_i estimations and causes its frequency dependence. Constant level of real

Q_i is then 3300-4000. Coda methods don't allow to study spatial distribution of attenuation for such a small areas like West Bohemia with its seismic network is.

The rheological properties of Earth materials are expressed by their seismic velocities and V_P/V_S ratio, which is easily obtained by the Wadati method. Its double-difference version based on cross-correlated waveforms enables focusing on very local structures and allows tracking, monitoring and analyzing the fluid activity along faults. We applied the method to three 2014 mainshock–aftershock sequences in the West Bohemia and found pronounced V_P/V_S variations in time and space for different clusters of events located on a steeply dipping fault zone at depths ranging from 7 to 11 km. Each cluster reflects the spatial distribution of earthquakes along the fault plane but also the temporal evolution of the activity. Low values of V_P/V_S ratio down to 1.59 ± 0.02 were identified in the deeper part of the fault zone whereas higher values up to 1.73 ± 0.01 were estimated for clusters located on a shallower segment of the fault. Temporally the low V_P/V_S values are associated with the early aftershocks, while the higher V_P/V_S ratios are related only to later aftershocks. We interpret this behavior as a result of saturation of the focal zone by compressible fluids: in the beginning the mainshock and early aftershocks driven by over-pressured fluids increased the porosity due to opening the fluid pathways. This process was associated with a decrease of the velocity ratio. In later stages the pressure and porosity decreased and the velocity ratio recovered to levels of 1.73, typical for a Poissonian medium and Earth's crust. Another possible interpretation is that the activity is on intersection f two geological units with different rheological properties and observed V_P/V_S is controlled by the position of the cluster.