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Detection of shallow crustal discontinuities from high frequency waveforms of swarm earthquakes in West Bohemia/Vogtland seismoactive area

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The western part of the Bohemian Massif, the West Bohemia/Vogtland region, is the area of the increased geodynamic activity manifested by repeated occurrence of intraplate earthquake swarms and fluid degassing. To understand geodynamic processes, knowledge of a detailed crustal structure is essential for all advanced studies of seismicity and focal parameters of the micro-earthquake swarms that occur in this region. The crustal structure is usually inferred from active seismic investigations, i.e. reflection and refraction seismic imaging. Passive seismic investigation focused on swarm microearthquakes has an advantage over the active exploration. The microseismic investigation typically handles large amount of data ideal for stacking, foci are usually far from the shallowest structure so waveforms are rather simple, and data acquisition is not expensive. The standard microseismic monitoring of swarms is prevalently used for retrieving information on seismic source parameters, such as magnitude, location, seismic moment, and moment tensors. However, high-frequency seismic waves generated by local sources are sensitive to sharp changes in velocities or density and the structure can be determined from reflected and converted phases secondarily originating at deep and shallow subsurface layers.

In our study we concentrate on the velocity distribution in the upper crust. The upper crustal structure is studied from waveforms of local microearthquakes that occurred during the 2008 swarm in West Bohemia/Vogtland seismoactive region. They were recorded by the WEBNET network consisting of 22 three-component seismic stations. We focus on high-frequency PS and SP converted waves generated at shallow interfaces at depths between 2 and 5 km. Apart from velocity contrast at the interfaces, the amplitudes of converted waves are significantly affected by source-receiver geometry and focal mechanisms of the earthquakes. This observation complicates the analysis, being absent in processing of standard active seismic experiments with sources of rather uniform radiation. The strong dependence of amplitudes of reflections/conversions on focal mechanisms and on the source-receiver geometry is confirmed by synthetic tests, which reveal preferential azimuths suitable for interpretation of data. We apply reflection seismic approach with data rotation into multi-azimuthal sections, data alignment and stacking to amplify reflected/converted phases, the ray tracing for calculation of the exact arrival times of phases, analysis of reflection/transmission coefficients in order to asses the amplitudes in real waveforms, synthetic modelling of full waveforms using the discrete wave number method to compare synthetic full wave fields with recorded data, and the grid search algorithm as the robust inversion method. Good azimuthal coverage of stations and proper attention paid to focal mechanisms and to the source-receiver geometry and especially their impact on the final shape of waveforms will enable to retrieve even the topography of interfaces.