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Moho depth determination from waveforms of microearthquakes in the West Bohemia/Vogtland swarm area

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The West Bohemia/Vogtland area is known for its increased geodynamic activity with reoccurrence of intraplate earthquake swarms. Previous geophysical studies, namely active and passive seismic investigations, revealed a high velocity lower crust in this area with increased reflectivity. To refine this result and retrieve a more detailed structure of the deep crust and the Moho discontinuity we analyzed waveforms of local microearthquakes that occurred in this area during the 2008 swarm and were observed at the WEBNET seismic network stations.

We developed a new multi-azimuthal approach in data processing to increase resolution of Moho phases in the waveforms. The waveforms typically display dominant direct P and S waves followed by converted and reflected waves secondarily generated at shallow and deep subsurface structure. Apart from the velocity structure and the source-receiver geometry, the waveforms are significantly affected by focal mechanisms of the earthquakes. Thus, the waveforms of earthquakes were grouped into clusters with similar focal mechanisms and clusters were processed separately. We applied the waveform cross-correlation of the P and S waves, and rotated, aligned and stacked the seismograms to extract the Moho SmS, PmP, and PmS reflected/converted phases. These phases were inverted for laterally varying Moho depth by ray tracing and a grid search inversion algorithm. The model retrieved was verified using modeling of full waveforms computed by the discrete wave number method.

The newly applied multi-azimuthal approach revealed details in the velocity structure of the crust/mantle transition at each station. Instead of a single interface with a sharp velocity contrast, the inversion indicates a reflective zone at Moho depths with one or two strongly reflective interfaces, which is in agreement with the zone interpreted by previous investigations. The thickness of the zone varies from 2-4 km within the depth range of 27-31.5 km and is delimited by reflections from its top and bottom boundaries, sometimes with strong reflectors within the zone. The average Vp/Vs ratio determined from the Moho reflections and conversions is 1.73.