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3D velocity structure of upper crust beneath NW Bohemia/Vogtland

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The 3D structure of the upper crust beneath west Bohemia/Vogtland region, analyzed with travel time tomography and ambient noise surface wave tomography using existing data. This region is characterized by a series of phenomena like occurrence of repeated earthquake swarms, surface exhalation, CO_2 enriched fluids, mofettes, mineral springs and enhanced heat flow, and has been proposed as an excellent location for an ICDP drilling project targeted to a better understanding of the crust in an active magmatic environment.

We performed a 3D tomography using P-and S-wave travel times of local earthquakes and explosions. The data set were taken from permanent and temporary seismic networks in Germany and Czech Republic from 2000 to 2010, as well as active seismic experiments like Celebration 2000 and quarry blasts. After picking P and S wave arrival times, 399 events which were recorded by 9 or more stations and azimuthal gap<160[U+25E6] were selected for inversion.
A simultaneous inversion of P and S wave 1D velocity models together with relocations of hypocenters and station corrections was performed. The obtained minimum 1D velocity model was used as starting model for the 3D Vp and Vp/Vs velocity models. P and S wave travel time tomography employs damped least-square method and ray tracing by pseudo-bending algorithm. For model parametrization different cell node spacings have been tested to evaluate the resolution in each node. Synthetic checkerboard tests have been done to check the structural resolution. Then Vp and Vp/Vs in the preferred 3D grid model have been determined. Earthquakes locations in iteration process change till the hypocenter adjustments and travel time residuals become smaller than the defined threshold criteria. Finally the analysis of the resolution depicts the well resolved features for interpretation. We observed lower Vp/Vs ratio in depth of 5-10 km close to the foci of earthquake swarms and higher Vp/Vs ratio is observed in Saxoturingian zone and surrounding area.
Surface wave tomography using ambient noise provides additional constraints on shear velocities. The detailed knowledge of the 3D structure is essential to select the optimal future borehole locations. we use the vertical and transverse component ambient noise data to estimate both Rayleigh and Love waves from ambient noise cross-correlation waveforms to investigate the crustal seismic structure of W-Bohemia/Vogtland.
More than 2000 Rayleigh and Love group-velocity dispersion curves are obtained by time-frequency analysis of stacked ambient noise cross-correlation functions between station pairs. We used the data between 2002 and 2004 recorded at 43 seismic stations from BOHEMA experiment and between 2006 and 2008 recorded at 79 seismic stations from permanent station networks of Germany, Czech Academy of Sciences (WEBNET) and PASSEQ experiments.
At each period between 1 and 10 s, group velocity maps are constructed, all corresponding to different sampling depths, and thus together giving an indication of the 3D shear wave velocity structure extending to a depth of about 15 km.