Geophysical Research Abstracts
Vol. 14, EGU2012-8737, 2012
EGU General Assembly 2012

Seismic tomography of the upper mantle beneath the Bohemian Massif (central Europe)

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We present a comprehensive test for teleseismic tomography of the upper mantle beneath the southern part of the Bohemian Massif (BM) based on data of passive experiments BOHEMA III and the northern part of the ALPASS (Mitterbauer et al., Tectonophysics 2011) as well as preliminary results. A new semi-automatic picker was applied for measuring P-wave arrival times from correlated extremes of waveforms recorded at 58 temporary seismic stations and 55 permanent observatories during 2005-2006. To calculate P-velocity perturbations, we selected 173 events from epicentral distances between 25° and 90°, and with magnitude higher than 4.5. Before the travel-time inversion itself, we analysed carefully relative P-wave residuals and cleaned the dataset of the travel-times from outliers and instabilities in timing for further processing. To eliminate leakage of crustal effects into the upper mantle velocity images, we corrected the observed travel-times for crustal structure according to 3D models of the BM and Eastern Alps crust (Karousova et al., Studia Geophys. Geod. 2012; Behm et al., GJI 2007). In order to optimize model parameterization, initial velocities and damping factors we perform different synthetic tests. Checkerboard and synthetic tests with artificial heterogeneities and shifted parameterization are calculated to explore sensitivity and resolution in individual nodes. Models with indistinctive velocity perturbations in the resolved parts tend to be more sensitive to ray geometry in the upper mantle and consequently could accentuate even insignificant heterogeneities.

We show series of velocity perturbation images in three parts of the BM retrieved in three successive passive seismic experiments BOHEMA I-III. No distinct ‘tube-like’ low velocity heterogeneity, which could be interpreted as a small plume beneath the Eger Rift is imaged in tomography in western BM from the BOHEMA I data. Relatively small velocity perturbations exist in the upper mantle beneath the remaining parts of the BM, characterized by lower velocities in general (BOHEMA II and BOHEMA III experiments, Karousova et al., Tectonophysics, in review). Though the seismic tomography calculated from data of the individual experiments does not indicate any significant velocity variations in the upper mantle beneath the BM, anisotropic studies result in 3D self-consistent models, which meet both the P-wave travel time deviations and shear-wave splitting, and according to which the mantle lithosphere of the BM is formed by several domains with their own consistent fabrics (Babuska et al., Tectonophysics 2008; Plomerova et al., Tectonophysics 2007; 2011). There is no doubt that standard seismic tomography represents a powerful tool to image isotropic velocity or velocity perturbations in the upper mantle. But for detailed structural studies particularly of the mantle lithosphere we need to consider also large-scale seismic anisotropy, which is natural characteristic of mantle rock constituents, and to concentrate on developing new codes, which would allow to include also anisotropic parameters into the inversion schemes (Eken et al., GJI 2011; O’Driscoll et al., GRL 2011).