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P-wave Receiver Functions reveal the Bohemian Massif crust

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In this study we present initial results of P-wave Receiver Functions (RF) calculated from broad-band waveforms of teleseismic events recorded by temporary and permanent stations in the Bohemian Massif (BM, Central Europe). Temporary arrays BOHEMA I (2001-2003), BOHEMA II (2004-2005) and BOHEMA III (2005-2006) operated during passive seismic experiments oriented towards studying velocity structure of the lithosphere and the upper mantle. Receiver Functions show relative response of the Earth structure under a seismic station and nowadays represent frequently-used method to retrieve structure of the crust, whose knowledge is needed in various studies of the upper mantle. The recorded waveforms are composites of direct P and P-to-S converted waves that reverberate in the structure beneath the receiver (Ammon, 1997). The RFs are sensitive to seismic velocity contrast and are thus suited to identifying velocity discontinuities in the crust, including the Mohorovičić discontinuity (Moho). Relative travel-time delays of the converted phases detected in the RFs are transformed into estimates of discontinuity depths assuming external information on the vp/vs and P velocity.

To evaluate RFs we use the Multiple-taper spectral correlation (MTC) method (Park and Levin, 2000) and process signals from teleseismic events at epicentral distances of 30 - 100º with magnitude Mw > 5.5. Recordings are filtered with Butterworth band-pass filter of 2 – 8 s. To select automatically signals which are strong enough, we calculate signal-to-noise ratios (SNR) in two steps. In the first step we calculate SNR for signals from intervals (-1s, 3s)/(-10s, -2s), where P-arrival time represent time zero. In the second step we broaden the intervals and calculate SNR for (-1s, 9s)/(-60s, -2s). We also employ forward modelling of the RFs using Interactive Receiver Functions Forward Modeller (IRFFM) (Tkalčić et al., 2010) to produce, in the first step, one-dimensional velocity models under individual seismic station.

Stacked traces of the RFs show strong conversions with positive polarity (indicating a velocity increase across the discontinuity) between 3.3 and 4.5 s after the P-wave arrival at almost all stations. We relate these pulses to conversions at the Moho discontinuity. Assuming a constant crustal vp/vs ratio (1.73) and average crustal velocity vp=6.3 km/s for all stations, analogically to Geissler et al (2012), we multiply the evaluated Ps delay times by factor of 8.3 km/s and estimate the Moho beneath the Bohemian Massif at depths between 27 and 37 km. The crust is thinnest in the western part of the BM, beneath the SW end of the Eger Rift. The Moldanubian part of the BM exhibits the thickest crust. At most of the stations we also see one or two intra-crustal conversions, sometimes stronger than that related to the Moho. Several stations exhibit significant variations of the RF with back-azimuth. The aim of this study is to update existing three dimensional P-velocity crustal model of the Bohemian Massif (Karousová et al., 2012) compiled from control-source seismic results.