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Crustal shear wave blockage in and around the Eastern Alps from the 2016 Alland earthquake

Petr Spacek[1], Pavel Zacherle[1], Götz Bokelman[2], Sven Schippkus[3], Rita Meurers[4], Jana Pazdírková[1], and the AlpArray Working Group[5]
[1]Masaryk University, Institute of Physics of the Earth, Brno, Czechia (spacek@ipe.muni.cz)
[2]University of Vienna, Austria
[3]University of Hamburg, Institute of Geophysics, Germany
[4]Zentralanstalt für Meteorologie und Geodynamik, Vienna, Austria
[5]www.alparray.ethz.ch

Earthquakes in the Eastern Alps are characterized by strongly elongated isoseismals, documenting significantly more efficient propagation of seismic waves towards the foreland (F) than into the orogen (O). In an effort to understand this phenomenon we analysed the local to regional wavefield of a single earthquake with ML4.2 / mb3.6 and epicenter WSW of Vienna (Alland) using instrumental data with unprecedented dense coverage (including AlpArray) and rich macroseismic observations. This earthquake with characteristic asymmetry of isoseismals and with the source located in the basement of the European plate just beneath the frontal thin-skinned thrust of the Penninic units is considered a representative example of the stronger historical and potential future earthquakes from this regionally important seismogenic source area. The analysis of macroseismic intensities and PGA, PGV and spectral content within time windows tied to Sg+Lg wavetrains and other interpreted phases indicates a very good match of smoothed high precision instrumental and high resolution macroseismic wavefields, which allows their joint interpretation. In the F-direction, a very small decrease of intensity and PGA values at an epicentral distance range between 30-50 km and 130-180 km is well approximated by intensity prediction equations derived for central and eastern North America. On the other hand, a sudden drop of respective values is observed at a distance of 20-30 km in the O-direction, correlating with the seismically active fault zone of Mur-Mürz line. The geographic distribution of regional distance-corrected PGA perturbations (dPGA) reveals several well-defined domains with internally limited variance whose boundaries partly correlate with known major geologic structures. Special attention has been paid to description of contrasts between the Foreland domain (Bohemian Massif + autochthonous sediments), the North Alpine domain (between the frontal thrust and Mur-Mürz line + its WSW continuation, i.e. close to southern limits of stable European plate) and the South Alpine domain (south of the former to the southern limits of the region of interest at latitude 46.2°N). The ratio of mean dPGA values observed in these three neighbouring domains is 1.00 : 0.27 : 0.05, respectively. Furthermore, significant contrast between the three domains is observed in terms of spectral content. High frequency signal above 10Hz is characteristic for the Foreland domain and strongly reduced in the South Alpine domain, suggesting that the structures related to the margin of stable

European plate act here as an efficient high-cut frequency filter. While map isolines of high frequency spectral amplitude are strongly elongated in F-direction, in agreement with PGA and macroseismic intensity, for frequencies below ~5Hz the isolines of spectral amplitude are quasi-isometric around the epicenter at least within distance of ~120 km. Combination of several mechanisms is considered to explain the wave energy propagation, including intrinsic attenuation at fault zones, blockage at waveguide inhomogeneities and Q(f) contrasts between the crustal domains. Numerous other interesting observations from the whole region including the Carpathian and Pannonian domains, demonstrate the strong potential of densely sampled earthquake wavefields for studies of crustal structure and seismic hazard in the generally low-rate seismicity areas.