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Seismic anisotropy and deformations of the TESZ lithosphere near the East European Craton margin in SE Poland at various scales and depths

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The area of SE Poland represents a contact of tectonic units of different consolidation age – from the Precambrian East European Craton (EEC), through Palaeozoic Malopolska (MB) and Lysogory Blocks (LB), to Cenozoic Carpathians and Carpathian Foredeep (CF). In order to investigate the structure, anisotropic properties and their relation to tectonic evolution of the area, several seismic datasets were used: seismic wide-angle off-line recordings from POLCRUST-01 deep seismic reflection profile, recordings from active deep seismic experiment CELEBRATION 2000 and teleseismic data from passive experiment PASSEQ.

Along the reflection profile POLCRUST-01, additional recorders were deployed every 1.2 km along the line in order to provide recordings of the Pg phase from the uppermost crust at 25-30 km offsets, complementary to the near-vertical data. In the SE part of the MB a 35 km long line of 14 recorders was deployed perpendicularly to the profile to record the Pg at wide range of azimuths for analysis of the azimuthal anisotropy. CELEBRATION 2000 experiment provided over 4000 off-line recordings of Pg phase at up to 150 km offsets, which were analyzed with the anisotropic tomography and delay-time inversion, providing information down to $\sim$15 km depths. PASSEQ 2006-2008 recordings of teleseismic events provided SKS seismograms from over 15 events, recorded in TESZ and EEC, which were analysed with SKS splitting method.

The modelling of POLCRUST-10 off-line refractions from the MB suggest $\sim$6% HTI anisotropy in 0.8-2.5 km depth range, with $\sim$125º azimuth of the fast velocity axis. Additionally, the in-line refracted phases were used for construction of the 2-D Vp model of the uppermost crust, constraining the structure down to $\sim$3 km depth. Contrary to the reflection image, where the Palaeozoic of the MB is quite transparent, some discontinuities were observed in the wide-angle data. They are likely to be related with stratigraphic boundaries between the Palaeozoic and older sediments of different age. To compare shallow anisotropy with independent information about anisotropy at larger depth, a subset of CELEBRATION 2000 data from MB area was also analysed by inversion. The model shows $\sim$9% HTI anisotropy with $\sim$128º orientation of the fast axis at depths down to $\sim$15 km. The results of the SKS splitting analysis show that the fast polarization azimuth in TESZ is roughly parallel to the margin of the EEC (120-130 deg), with values of splitting intensity larger than beneath the EEC. Observed fast azimuths correlate with orientation of the contact of the tectonic units, rather than with APM direction, therefore S-wave splitting beneath TESZ can be attributed to frozen-in lithospheric anisotropy reflecting deformations during accretion at the EEC margin.

Local-scale shallow anisotropy in MB confirms the large-scale anisotropy suggested by previous studies based on data from a broader area at larger depth. It is interpreted as a result of strong compressional deformation during the Palaeozoic accretion of terranes to the EEC margin, leading to tight folding and fracturing of intrinsically anisotropic metasediments forming the MB basement. Furthermore, the lithosphere at mantle depths also seems to exhibit anisotropy coherent with crustal anisotropy, which indicates that the deformations might have consistently influenced the whole lithosphere.