New refraction/wide-angle reflection profile across the Teisseyre-Tornquist Zone offshore Poland

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The southern Baltic Sea area is located in the transition zone between the East European Craton (EEC; Baltica) and the West European Platform (Avalonia). The most prominent tectonic feature in the area is the NW–SE trending Tornquist Zone (TZ), crossing the southern Baltic Sea area between Scania in Sweden and Pomerania in Poland. A peculiar feature of the TZ and its southern prolongation (Teisseyre-Tornquist Zone, TTZ) is possibly a crustal keel that was recently postulated for northern Poland based on potential field modelling. A crustal keel was also imaged in the Baltic Sea by BABEL profile A, which crossed the TZ northwest of Bornholm, and by two TTZ92 profiles crossing the TTZ south of Bornholm. However, the DEKORP-PQ profile shows a flat Moho across the TTZ.

In order to reconcile those contrasting interpretations of the crustal structure around the TTZ offshore Poland, a 230-km long refraction/wide-angle reflection profile was acquired across the TTZ in the course of RV/MARIA S. MERIAN expedition MSM52 (BalTec) in March 2016. This profile is nearly parallel to the western Polish coast, in half a distance to Bornholm. The data acquisition was conducted with 15 ocean bottom seismometers (OBS) and 3 land stations. The source array consisted of 8 G-guns with the total volume of 32 litres. In total 2227 shot points were recorded. Hydrophone data are of high quality and despite the relatively small source volume, sharp first arrivals of Pg and Pn are observed at over 120 km offsets. Some seismic record sections show clear PmP phases beginning at offsets of 70 km, continuing till the end of the profile.

Two variants of seismic modelling were performed, which results proved to be similar in terms of P-wave velocities and observed features. Tomographic joint inversion of both first arrivals and Moho reflections was used to extend velocity model depth range. Second was trial-and-error forward modelling technique using all identified seismic phases, paying attention to minimize misfit between calculated and observed P-wave travel times for each individual layer.

In the area of the TTZ, a complex upper crustal structure deepening towards the southwest is observed. One of the most interesting features is an increase in Vp (>6.5 km/s) at a depth of 16-25 km, offset by ~40 km from the TTZ on the EEC side. Similar feature was observed along the TTZ in SE Poland. Due to the lack of information from refraction, the presented ray-tracing model is the
result of testing various possible velocity values for the lower crust in different parts of the model. A layer with Vp>7 km/s with a thickness of ~6 km along the entire model seems to be the best solution. The Moho boundary was inferred at 33-38 km depth, deepening towards the EEC, with ~3 km uplift (but not keel) corresponding to the location of the elevated middle-crust velocities. Final velocity models were further verified by forward potential field modelling, testing various Vp – density relations.

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