TTZ-South seismic profile reveals the lithospheric structure along the SW border of the East European Craton in SE Poland and NW Ukraine

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The TTZ-South experiment in September 2018 aimed at exploring crustal and uppermost mantle structure along the Teisseyre-Tornquist Zone (TTZ), using the seismic wide-angle reflection/refraction (WARR) method. The ~550 km long profile, following the border of the East European Craton (EEC) with the Trans-European Suture Zone (TESZ) in SE Poland (~230 km) and western Ukraine (~320 km), is an extension of earlier profiles, TTZ (1993, NW Poland; Grad et al. 1999) and CEL03 (2000, SE Poland; Janik et al. 2005). In the experiment, 320 mobile single-component seismographs recorded eleven shot points, five in Poland and six in Ukraine, comprising 400-1000 kg of explosives in drill holes. The combined profiles TTZ, CEL03 and TTZ-South make up a 1025 km-long lithospheric transect between the Baltic Sea and Moldova. Two methods of seismic data modelling were used. 2-D tomographic inversion was applied to produce a smooth P-wave velocity (Vp) model based on first arrival travel times. This was followed by ray-tracing trial-and-error modelling and the computation of synthetic seismograms using a full waveform finite-difference code, for the final trial-and-error model. The model starting at 450 km in the NW and ending at 1025 km in the SE, shows strong lateral variations in crustal structure. Its Ukrainian segment crosses the interior of the EEC, where the top of the crystalline crust (Vp = 6.15-6.25 km/s), occurs at ~2 km depth at the SE end of the profile and dips to ~12 km at the Ukrainian-Polish border. This segment shows a four-layer crustal structure, with a sedimentary layer and crystalline upper crust up to 15 km thick, a 10-15 km thick middle and mainly ~15 km thick lower crust. In Poland, the profile enters and continues within the TTZ, at the border along the EEC and TESZ, which makes the structural image complex. At 630-700 km the crystalline basement occurs at ~15 km depth, corresponding to the top of the middle crust (Vp ~6.5 km/s below it), whose depth oscillates from 10-17 km at 490-630 km. This mid-crustal layer disappears at ~485 km at a major fault zone. From 450-490 km, the crystalline basement is either downthrown to ~15 km, where it starts to follow an upper crustal reflector, as in Ukraine, or even to

>25 km, where the lower crust occurs. The central profile (600-700 km) reveals a three-layer structure with a ~15 km thick sedimentary layer, a 10-15 km thick middle crust and a ~20 km thick lower crust. From 490-600 km, a conspicuous velocity inversion occurs, where a ~10 km thick mid-crustal layer overlies one with upper crustal velocities. Another sub-horizontal velocity inversion can be traced along almost the entire Ukrainian profile segment in the crystalline upper crust. Both these laterally extensive velocity inversions may have resulted from thick-skinned thrusting due to either late Precambrian collision with terranes accreting to the SW margin of the EEC or to Variscan orogenic events. Five high velocity bodies (HVB; V_p = 6.85-7.2 km/s) were detected in the middle and lower crust, at 15-37 km depth. The Moho varies substantially along the profile. It is at ~42 km depth in the NW and deepens SE-ward to ~50 km at ~685 km. Subsequently, it rises abruptly to ~43 km and sinks again to ~50 km at ~785 km. From this point until the SE end of the profile, the Moho gently shallows, up to a depth of ~37 km. Along the whole profile, sub-Moho velocities are ~8.05-8.1 km/s, and at depths of 57-63 km Vp reaches 8.2-8.25 km/s. Four reflectors/refractors were modelled at mantle depths of ~57-65 km and ~80 km.