Crustal structure along the fossil margin of Baltica: what we learned from the PolandSPAN project?

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The beginning of the second decade of the 21st century has revolutionized the study of the deep structure of the Earth's crust in Poland. Intensification of shale gas exploration indirectly contributed to the acquisition of the first regional deep reflection seismic profiles in Poland including ION Geophysical PolandSPAN™ project. It comprises a net of 10 regional seismic profiles with a total length of about 2,200 km. Although these profiles were mainly aimed at the regional characterization of the lower Paleozoic shale basins developed along the margin of the East European Craton (EEC), the measured data enable imaging of the whole crust through the application of the extended correlation method and recent reprocessing efforts. New seismic data coupled with the potential field modelling have been used to challenge the existing paradigm of the Teisseyre-Tornquist Zone (TTZ) being an edge of the EEC, along which Paleozoic terrane accretion was supposed to happen. In the new interpretations, the TTZ constitutes a relict structure inside the EEC itself, likely associated with a crustal necking zone. The Precambrian EEC basement in Poland belongs to Fennoscandia in the NE and to Sarmatia in the SE part. PolandSPAN™ data provided unique opportunity to study changes in the crustal structure between those two EEC building blocks. Profiles from northern Poland show reflectivity patterns, which are similar to those observed along the BABEL and FIRE profiles in the Baltic Sea and Finland and typical of the Paleoproterozoic crust formed during the Svekofennian (Svekobaltic) orogeny. We infer two sets of structures that can be collectively interpreted as kilometer-scale S-C' shear zones formed due to a mid- to lower-crustal, orogeny-normal, lateral flow. Those structures define a penetrative deformation fabric invoking ductile extension of hot orogenic crust in a convergent setting. Localized reactivation of these structures provided conduits for subsequent emplacement of gabbroic magma that produced a Mesoproterozoic anorthosite-mangerite-charnockite-granite (AMCG) suite in NE Poland. Data from SE Poland are located in the area of the Fennoscandia – Sarmatia junction (1.9-1.8 Ga), overprinted with the magmatic effects of the Neoproterozoic mantle plume producing the Volyn Large Igneous Province. Seismic data reveal crustal fabric that can be characteristic of the transitional/Sarmatian crust with the boundaries of different units (e.g. Belarus-Podlasie granulite belt) marked by the change in reflectivity patterns (reflection density, truncations). Later magmatic activity is expressed as either reflection-free zone associated with the occurrence of high-velocity/high-density bodies or as a subhorizontal reflectivity located close to the top of the lower-crust or at mid-crust levels (20/25-30/35 km depth) – ca. 7-10 km above the Moho. The latter can invoke an unknown mechanism of trapping mafic magmas or partial-melting restites at mid-crustal depths.

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