Seismic processing and imaging of the new 2D marine reflection seismic data in the Polish sector of the Baltic Sea
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Introduction
Geological structure and tectonics of the Phanerozoic sedimentary cover within the transition zone between the Precambrian and Paleozoic platform in the Polish sector of the Baltic Sea was imaged using new 2D high-resolution multi-channel seismic reflection data. These data were acquired in 2016 during the course of RV Maria S. Merian expedition MSM52 (Hübischer et al. 2017) within the framework of the BalTec project. Eight profiles (with the total length of ca. 850 km, Fig. 1) covered the tectonic blocks located within the Polish Exclusive Economic Zone, stretching from the East European Craton (EEC) to the Paleozoic platform across the Teisseyre-Torquist Zone (TTZ, here coincident with the Koszali-Fault).

Data Acquisition
The 2D seismic reflection data was acquired with following parameters:
- Shot type / interval: Air gun array / 25 m
- Receiver interval: 12.5 m
- Number of groups / Receivers numbers: 7 / 216 channels
- Near / Far offset: 32.8 km / 2274 km
- Natural CDP spacing / natural fold: 6.25 m / 54
- Acquisition sample: 1ms data processing at 2ms

Seismic processing and imaging
Our in-house seismic processing workflow (Fig 2.) focused on removing multiples contaminating this shallow-water data (both water bottom and interbed related). Various demultiplex techniques such as SRME, TAU-P domain deconvolution, high resolution parabolic Radon demultiplex and SWDM (shallow water demultiplex) have been tested. Combination of all those techniques at different stages of the processing with some modifications based on a particular seismic profile proved to be the most effective. Consequently, multiples obscuring seismic sections were efficiently reduced. Data were processed up to Kirchhoff pre-stack time migration.

Since SRME was introduced to the industry (Verschuur et al., 1992), it is widely used as one of the most efficient approach to suppress first-order multiples, it was applied to MSM52 data using typical SRME workflow: interpolating shot gather (25 m) to 12.5 m (receiver interval), predicting and modelling multiple events and then adaptive subtraction (Monk et al., 1993) of the modelled multiples (Fig 3).

One of the challenges in processing this data are multiples in the deeper part of the section, as it affects velocity analysis. Therefore, Radon demultiplex was applied to remove these multiples. After parabolic Radon approach, multiples were suppressed especially in the near-offset. It has a clear effect on the velocity semblance spectra, which was improved for more easily picking velocity (Fig. 4).

To enhance structural imaging, pre-stack Kirchhoff time migration was applied to remove dip effects, diffractions and noises. A post-stack time migration image was also produced to compare result with pre-stack time migration. Comparison shows image enhancement when applying pre-stack in stead of post-stack time migrations, especially at fault locations (Fig. 5).

Conclusions
We established processing workflow up to pre-stack time migration for the new seismic data acquired in the southern Baltic Sea during MSM52 cruise. It will be applied to all the profiles in order to provide a uniform dataset for interpretation. The longest seismic profile (line 212, Fig. 6, ca. 240 km long) crosses almost perpendicular a majority of Precambrian and Paleozoic fault systems bordering the tectonic blocks of the EEC basement, so fault systems could be easily interpreted. EEC Precambrian basement is characterized by a regional flexure towards the TTZ, Cambrian-Ordovician exhibits similar geometry and is characterized by a relatively constant thickness related to deposition on the Tornquist Ocean passive margin. Thin Slavonian succession (Fig. 7) is characterized by a regional divergent pattern caused by deposition within the Callovian foredeeps. Structural pattern within the W part of the study area is much more complex as this area underwent Late Paleozoic extension/transtension, Variscan inversion, Permo-Mesozoic subsidence and Late Cretaceous inversion. An unresolved issue is the depth extent of the Precambrian basement. It can be tracked till the Koszali Fault, but later it becomes diffuse and hard to correlate, with some hints it can drop significantly.

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References