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# 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 (Huebscher et al. 2017) within the framework of the BalTec project. Eight profiles (with the total length of ca. 850km, Fig. 1) covered the tectonics 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 Koszalin 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 m / 2724.8 m
- 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 demultiple techniques such as SRME, TAU-P domain deconvolution, high resolution parabolic Radon demultiple and SWDM (shallow water demultiple) 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 (Veschuur et all., 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 gathers (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 demultiple 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).

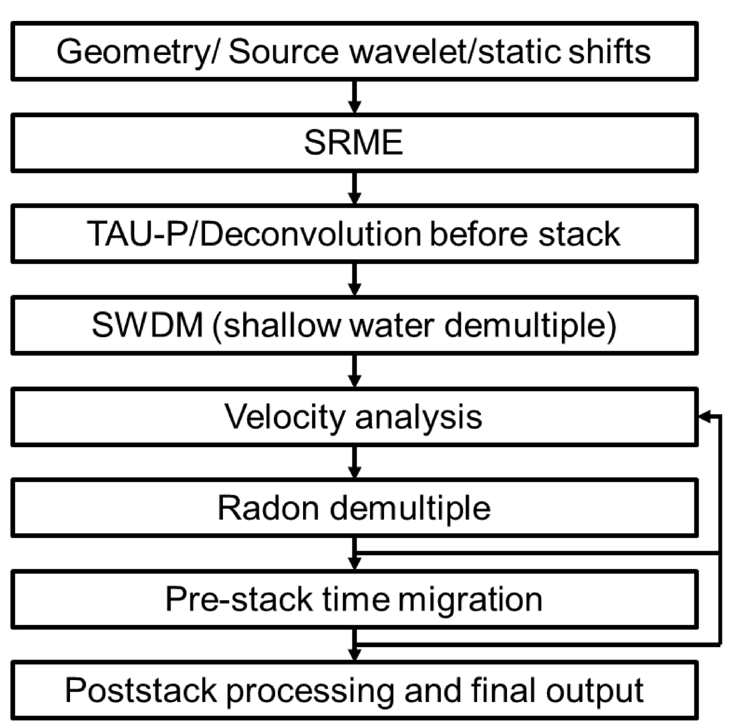


Figure 2. Seismic processing flow with the key processing techniques applied to MSM52 data.

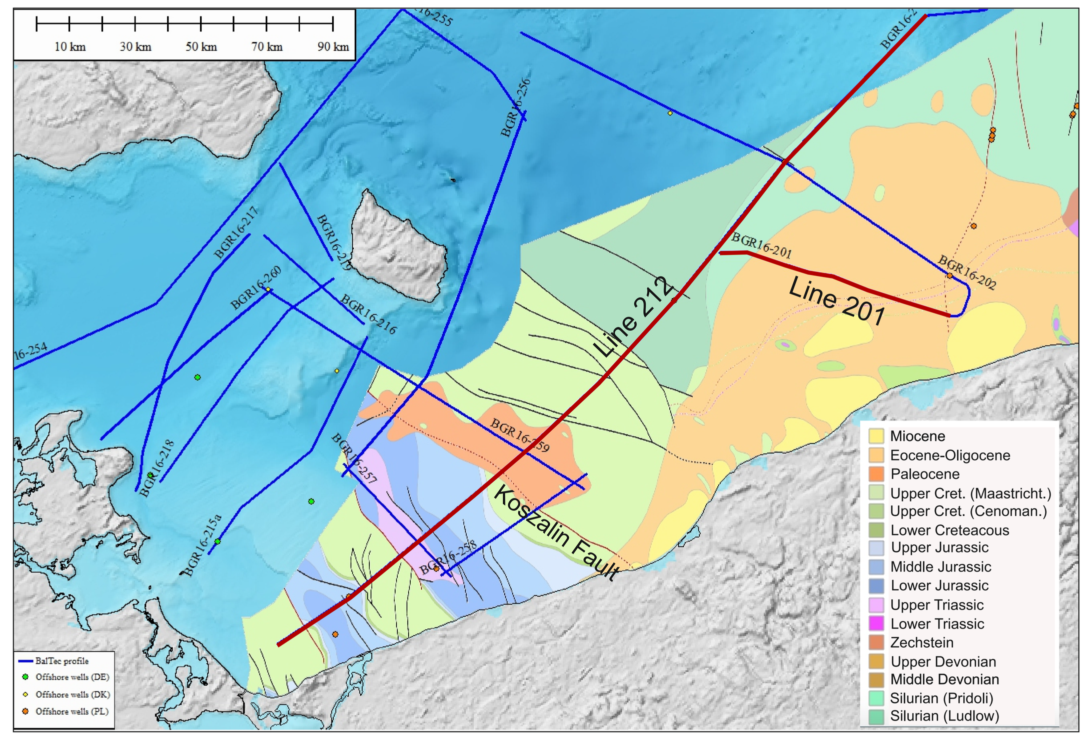


Figure 1. Location of the MSM52 seismic profiles (blue lines) at the geological map of the Polish sector of the Baltic Sea without the Quaternary (WMS service of the Polish Geological Institute - National Research Institute). Seismic sections for lines marked in red are shown to the right.

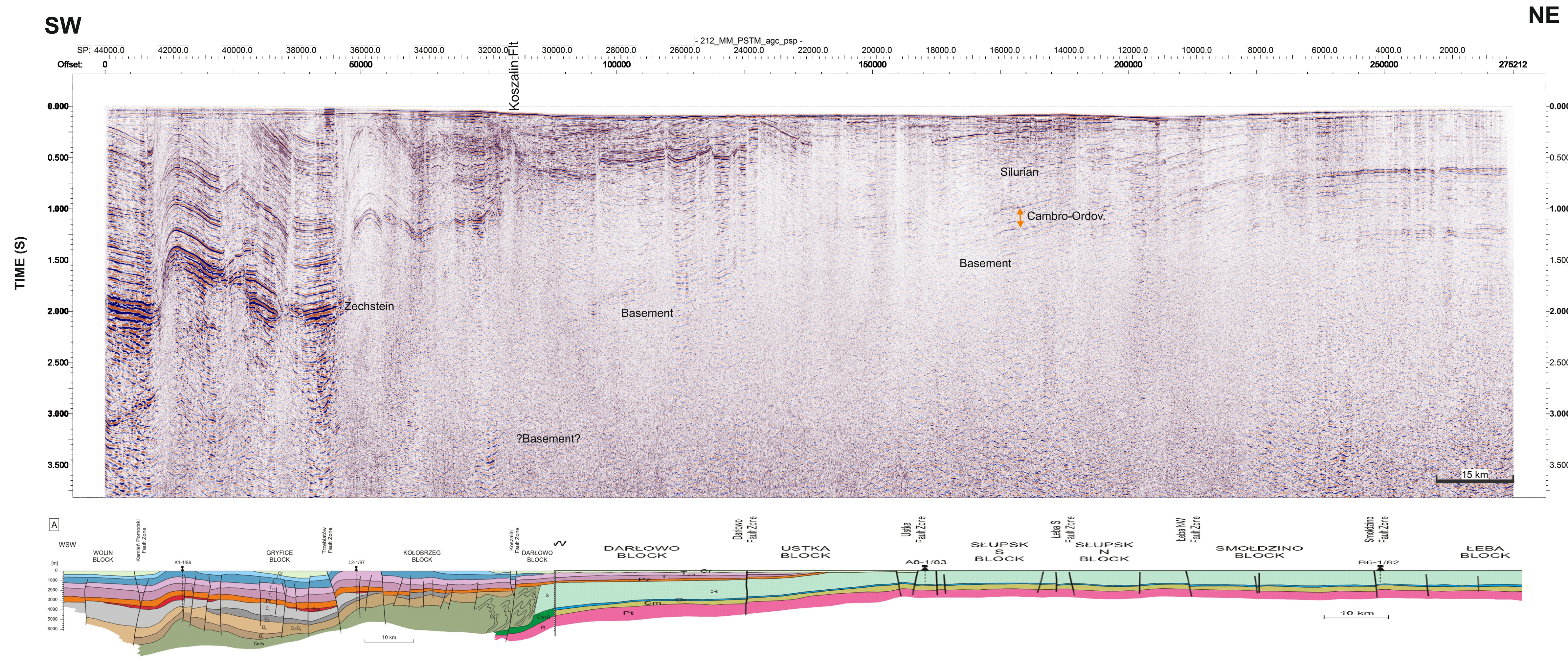


Figure 6. Pre-stack time migrated section along line 212 (top) correlated with the geological cross-section approximately along the same profile from Jaworowski et al. (2010) (bottom)

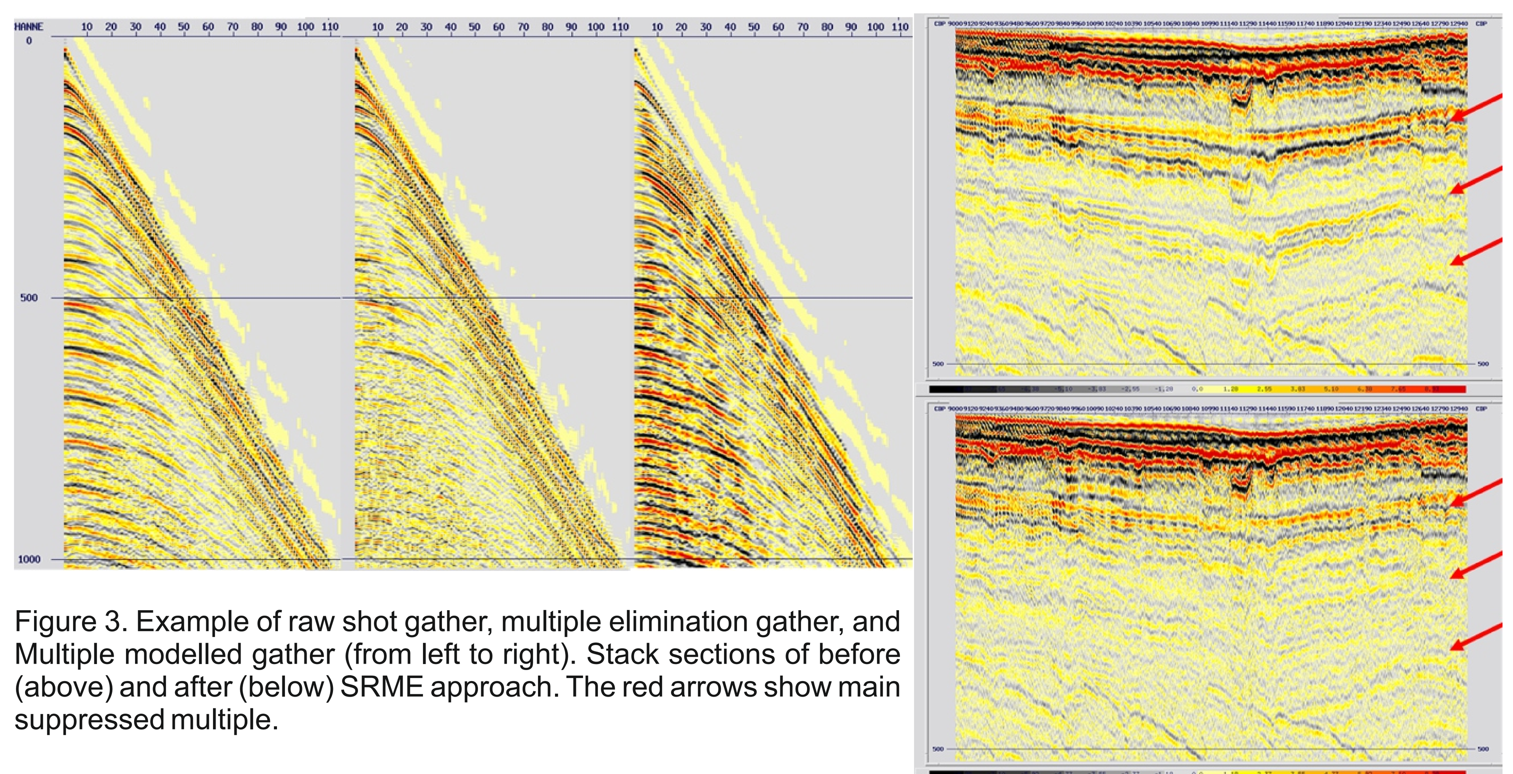

Figure 3. Example of raw shot gather, multiple elimination gather, and Multiple modelled gather (from left to right). Stack sections of before (above) and after (below) SRME approach. The red arrows show main suppressed multiple.

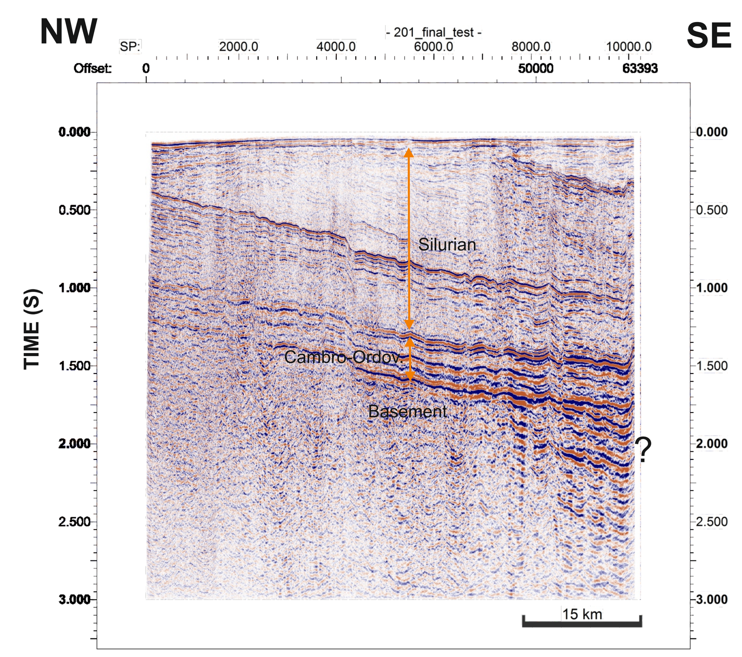


Figure 7. Pre-stack time migrated section along line 201

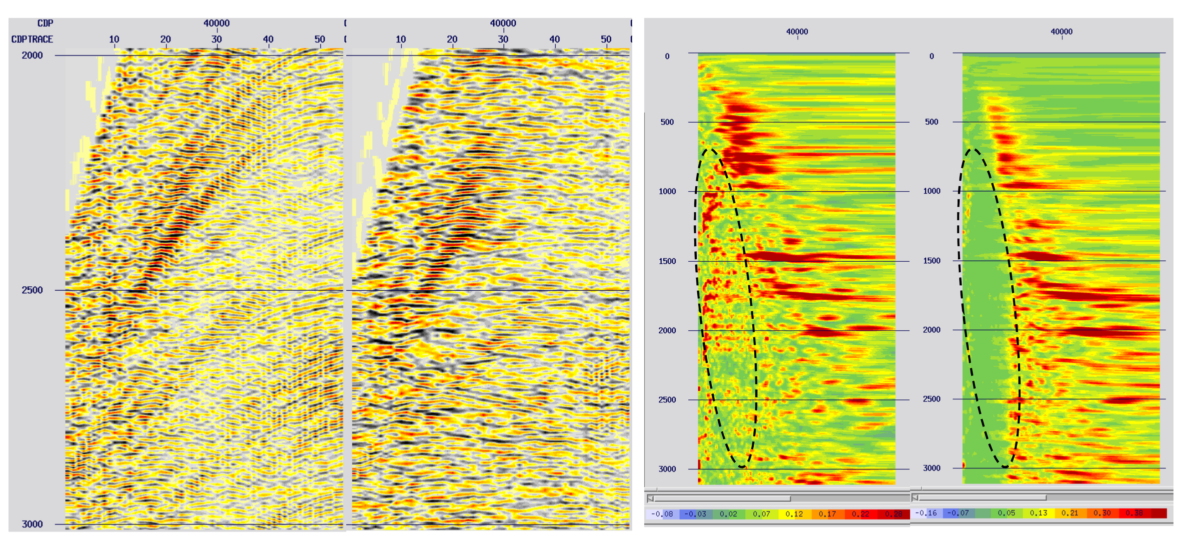

Figure 4. Example of CMP gather before and after Radon demultiple approach and its velocity semblance. Black dashed line shows low velocities removed by filtration.

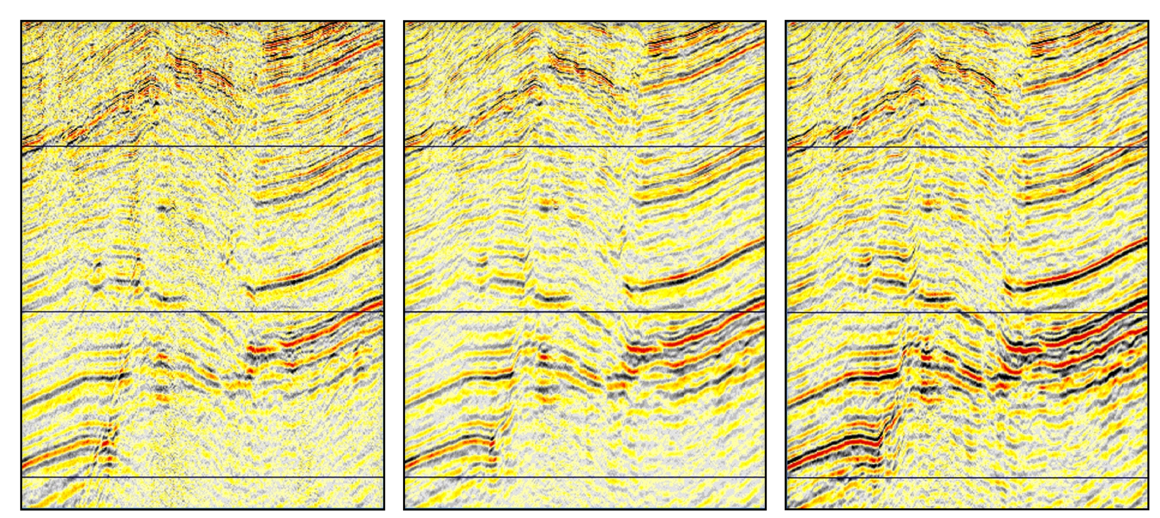

Figure 5. Example of fault areas in seismic sections before (left), after post- stack time migration (middle) and after pre-stack time migration (right).

## 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 perpendicularly 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. Thick Silurian succession (Fig. 7) is characterized by a regional divergent pattern caused by deposition within the Caledonian foredeep basin. 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 extend of the Precambrian basement. It can be tracked till the Koszalin Fault, but later it becomes diffuse and hard to correlate, with some hints it can drop significantly.

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