Three-dimensional depth-to-basement modelling based on seismic and potential field data – basement configuration in the westernmost Polish Outer Carpathians

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The Silesian Nappe in the westernmost part of the Polish Outer Carpathians Fold and Thrust Belt exhibits simple, almost homoclinal character. Based on the field observations, a total stratigraphic thickness of this sequence equals to at least 5400 m. On the other hand, the published maps of the sub-Carpathian basement show its top at depths no greater than 3000 m b.s.l. or even 2000 m b.s.l. in the southern part of the Silesian Nappe. Assuming no drastic thickness variations within the sedimentary sequence of the Silesian Nappe, such estimates of the basement depth are inconsistent with the known thickness of the Silesian sedimentary succession. The rationale behind our work was to resolve this inconsistency and verify the actual depth and structure of the sub-Carpathian crystalline basement along two regional cross-sections. In order to achieve this goal, a joint 2D quantitative interpretation of gravity and magnetic data was performed along these regional cross-sections. The interpretation was supported by the qualitative analysis of magnetic and gravity maps and their derivatives to recognize structural features in the sub-Carpathian basement. The study was concluded with the 3D residual gravity inversion for the top of basement. The cross-sections along with the borehole data available from the area were applied to calibrate the inversion.

In the westernmost part of the Polish Outer Carpathians, the sub-Carpathian basement comprises part of the Brunovistulian Terrane. Because of great depths, the basement structure was investigated mainly by geophysical, usually non-seismic, methods. However, some deep boreholes managed to penetrate the basement that is composed of Neoproterozoic metamorphic and igneous rocks. The study area is located within the Upper Silesian block along the border between Poland and Czechia. There is a basement uplift as known mainly from boreholes, but the boundaries and architecture of this uplift are poorly recognized. Farther to the south, the top of the Neoproterozoic is buried under a thick cover of lower Palaeozoic sediments and Carpathian nappes.

Our integrative study allowed to construct a three-dimensional map for the top of basement the depth of which increases from about 1000 m to over 7000 m b.s.l. in the north and south of the study area, respectively. Qualitative analysis of magnetic and gravity data revealed the presence of
some basement-rooted faults delimiting the extent of the uplifted basement. The interpreted faults are oriented mainly towards NW-SE and NE-SW. Potential field data also document the correlation between the main basement steps and important thrust faults.

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