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Integrated interpretation of geophysical data in the Carpathians

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Abstract. Being one of the first known oil provinces in the world, the Carpathian region is the area of numerous hydrocarbon discoveries. The existing fields are mostly at shallow depths. However, there are indications that hydrocarbon accumulations also occur at greater depths. In spite of using modern seismic equipment and advanced methods of seismic data processing, the results obtained so far unable us to locate the actual position of these deep productive horizons.
In the light of the obtained results, magnetotelluric and gravity surveys are an important component of the integrated geologic interpretation. The results of magnetotelluric and gravity surveys can supplement the interpretation of seismic sections in the Flysch Carpathians as well as make a valuable contribution to future exploration activities in the Carpathians.

Key words: Carpathians, Magnetotelluric, Gravity, Integrated interpretation

Being one of the first known oil provinces in the world, the Carpathian region is the area of numerous hydrocarbon discoveries. The existing fields are mostly at shallow depths. However, there are indications that hydrocarbon accumulations also occur at greater depths. In spite of using modern seismic equipment and advanced methods of seismic data processing, the results obtained so far unable us to locate the actual position of these deep productive horizons.

Due to the limitations of seismic interpretation it is necessary to employ additional geophysical exploration techniques. On the basis of the experience so far, magnetotelluric and gravity methods, which are mainly applied to structural and tectonic issues, should be considered the most effective in the Carpathians.

The magnetotelluric surveys are currently being conducted along several section lines in the Carpathians (PBG - Geophysical Exploration Company – Warsaw) using sophisticated measurement equipment, which produces a high resolution image. The interpretation of the obtained data encompasses the structural setting of the Carpathian Flysch as well as its basement.

The detailed interpretation of the magnetotelluric data enables us to locate the Mesozoic or Paleozoic top surface as well as to distinguish geoelectrically defined, lithostratigraphic complexes within the Carpathian basement (Fig. 1). This method is also useful in detecting the zones of tectonic deformations.

The effectiveness of magnetotelluric measurements for the mapping of tectonic deformation zones is demonstrated in the Radoszyce-Przemyśl section No 16 (Fig. 2) where the Kniazyce fault zone is detectable. Similarly, in the vicinity of the Cisowa IG-1 well, the fault which is observed in the sub-Miocene basement may be associated with the southeastern extension of the Main Mielec-Rzeszów fault. In the southern and central parts of this section there are clearly detectable geoelectric complexes which reflect the inner structural setting of the Carpathian-Stebnik thrust. The boundaries of these complexes are especially well correlated with the subsurfaces of main tectonic units and major slices.

The magnetotelluric techniques enable the identification of thick lithostratigraphic complexes within the overthrust nappes of the Carpathian Flysch (e.g. Krosno Beds, Inoceramian Beds) as well as the boundaries of major thrusts and slices.

The applications of gravity surveys in the exploration for oil and gas have been possible on a broader scale since the gravity data from the Carpathian area were standardized. The interpretation of these data enables tracking down the axis of major synclines and anticlines as well as the fault and tectonic shear zones. In the marginal parts of the Carpathians it is possible to identify the elevated structures within the sub-Miocene basement.

The applications of gravity surveys in the exploration for oil and gas were demonstrated on the example of the Hermanowa structure (Fig. 3). A distinct gravity anomaly observed in the gravity map can be attributed to the structural elevation of the basement. The geological data obtained from the Hermanowa-1 well and the interpretation of the seismic sections confirm such a possibility. The interpretation of this anomaly is somewhat ambiguous due to its conformity to the anticline which occurs in the Flysch. This may indicate that the structural elements of the Flysch are aligned with the underlying structural setting.

In the light of the obtained results, magnetotelluric and gravity surveys are an important components of the integrated geologic interpretation. The results of magnetotelluric and gravity surveys can supplement the interpretation of seismic sections in the Flysch Carpathians as well as make a valuable contribution to future exploration activities in the Carpathians.

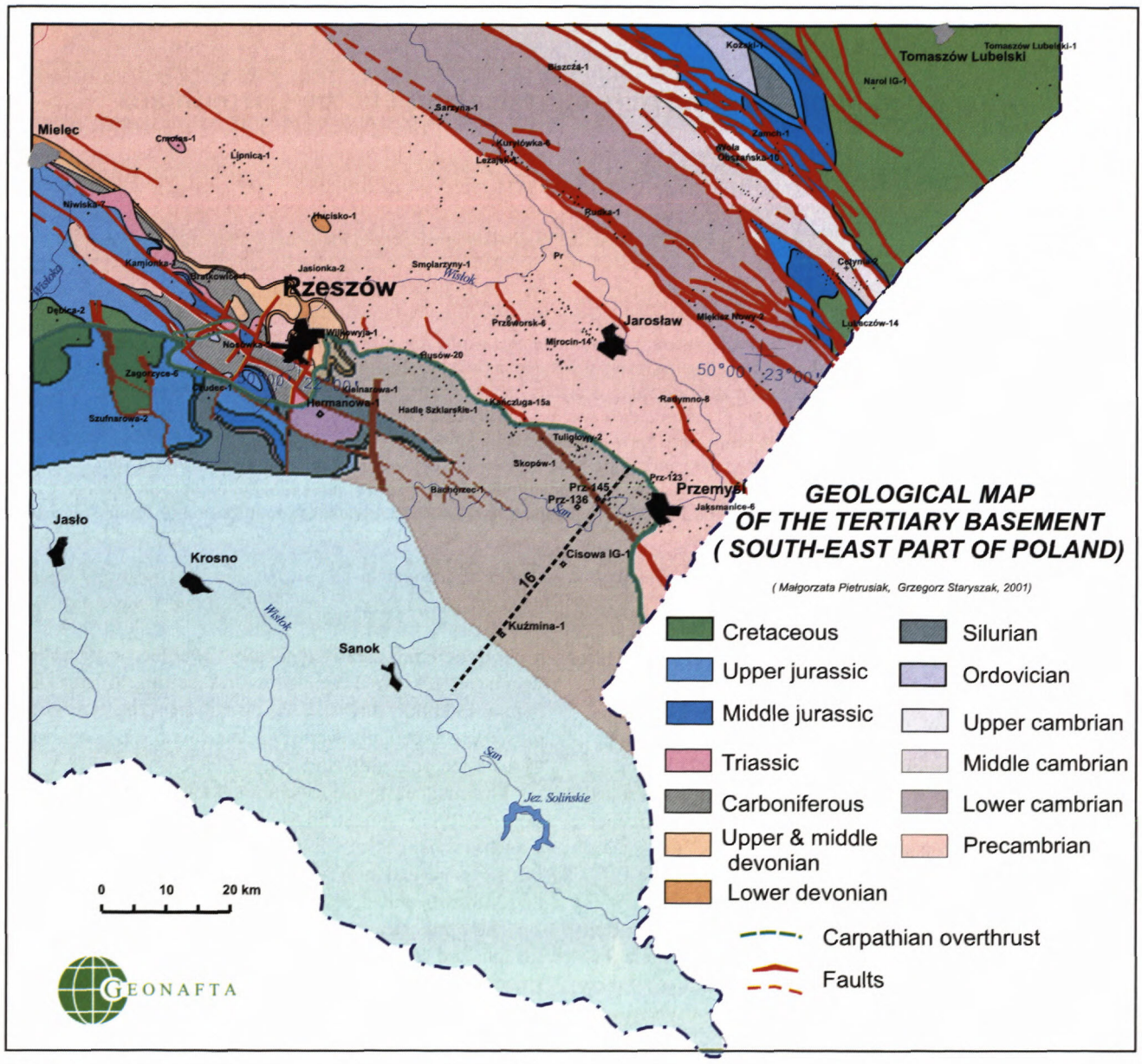

Fig. 1 Geological map of the Tertiary basement (S-E part of Poland)

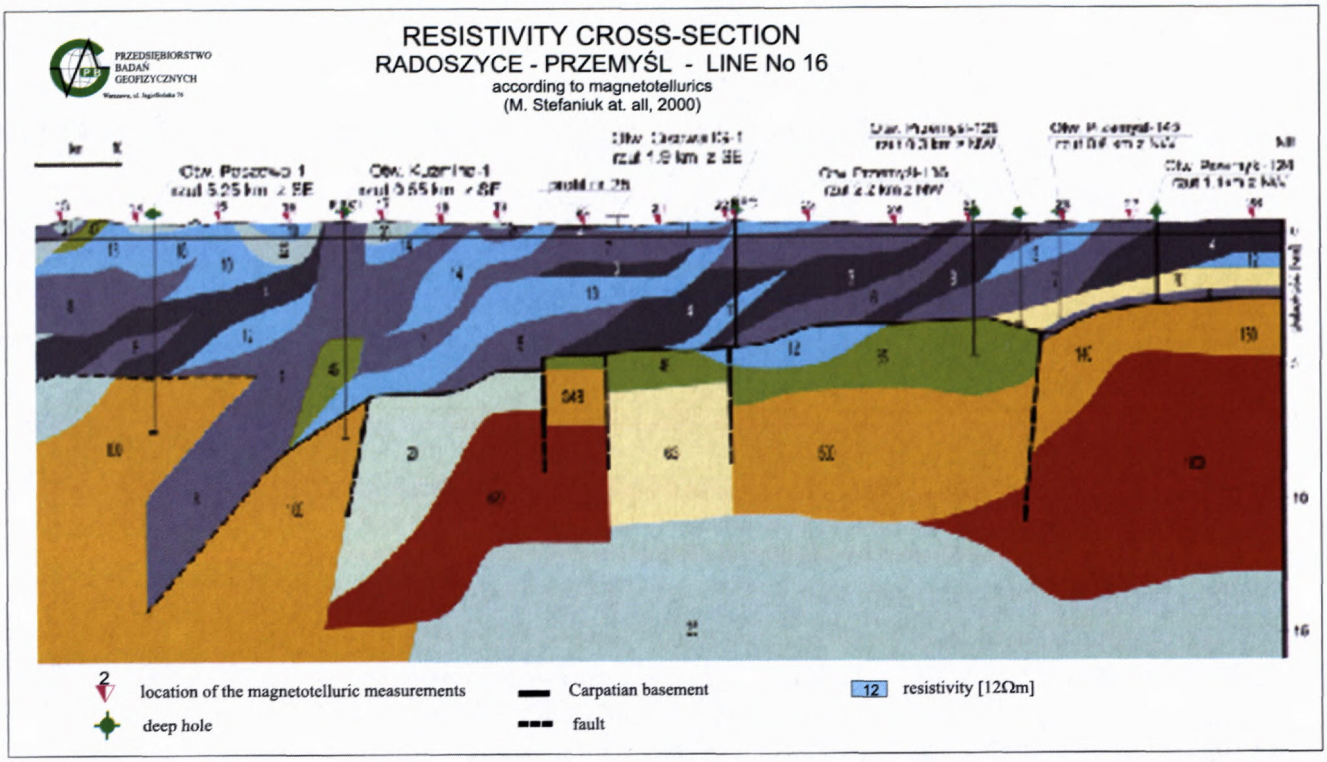

Fig. 2 Resistivity cross-section of Radoszyce – Przemyśl Line No 16

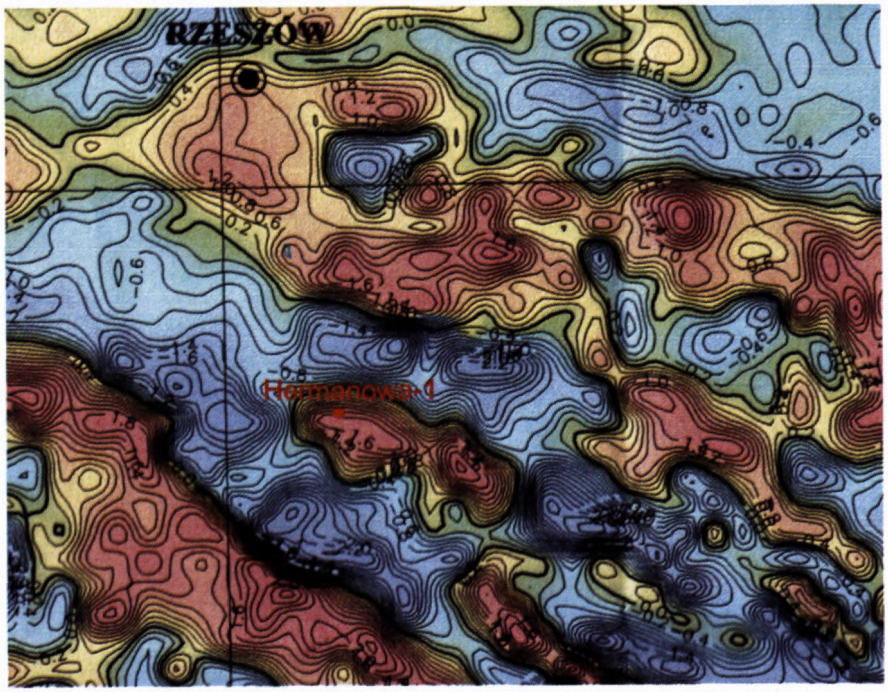

Fig. 3 Map of residual gravity anomaly – Hermanowa region