APPLICATION OF ENGENEERING GEOPHYSICAL SURVEY FOR DETECTING SUBSURFACE LITHOLOGY AND SMALL TECTONIC ZONES. EXAMPLE FROM TESTING PROFILE LOCATED NEAR WAŃKOWA OIL DEPOSITS.

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Introduction

This article presents the results of a comprehensive (complex) interpretation of measurements made using methods of engineering geophysics. Electro-Resistivity Tomography (ERT), Electromagnetic Conductivity Method (ECM) profiling, Seismic Refraction Tomography (SRT) as well as deep and shallow Induced Polarization (IP) tomography were used in the study. The obtained results were used to build a geophysical model of the subsurface zone, which formed the basis for a detailed geological and tectonic interpretation, aimed at recognizing shallow hydrocarbon deposits.

Methods

Detailed research on the methods of engineering geophysics was carried out in a small area in the Eastern Carpathians by the Wańkowa oil deposit, near the towns of Brelików and Ropieńka. The test geophysical profile has a length of 2.6 km with an oil deposit located near its central part (Figure 1). Field work was carried out by the PBG Geophyscial Exploration Ltd. as part of a research project. This project has implemented a deep Induced Polarization (IP) tomography with IRIS Instruments equipment as a tool for recognizing shallow hydrocarbon deposits. The classic Electro-Resistivity Tomography ERT and the Induced Polarization IP tomography were applied using ARES II equipment. Seismic measurements were carried out using the Terraloc MK6 seismometer. The source of the seismic wave was a 10 kg hammer. Additionally, conductivity profiling using 6 independent frequencies was carried out along the test profile.

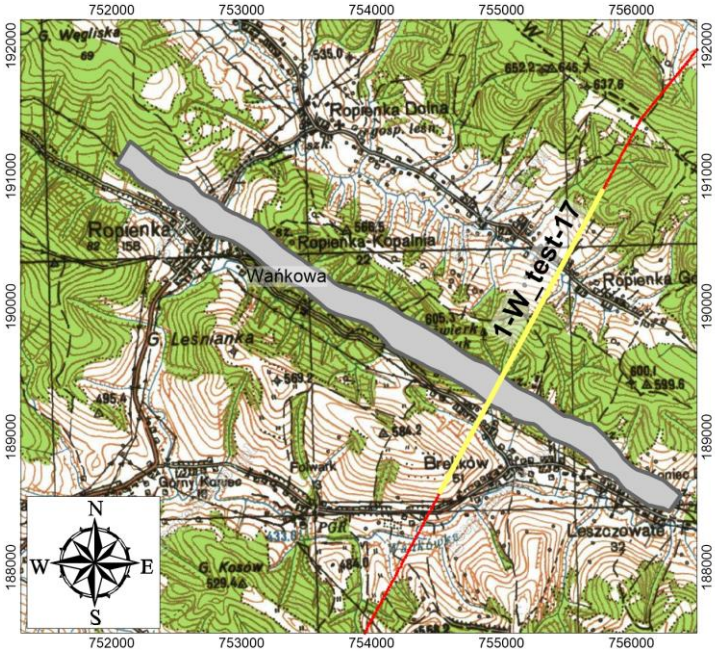

Figure 1. *Location of testing profile on the background of topographic map in PUW92 coordinate system – yellow line, seismic reflection line – red line. (Source of map: http:// maps. geoportal.gov.pl).*

Results

Interpretation of ERT data (in a deep and shallow versions) allowed to obtain resistivity cross-sections. These methods are sensitive to changes in lithology, mainly boundaries (contacts) of sandy and clay sediments as well as sandstones and shales building flysch sediments. The seismic tomography method (SRT) allows verification of elastic parameters of rocks. Generally, the collected and interpreted data allowed to create a generalized model showing the geological and tectonic conditions of the rocks located above the oil deposit. The chargeability, as the induced polarization parameter, has made it possible to identify contacts between sandstones and shales and the zone of pyritization over the deposit (Wojdyła et. al., 2011). The results of interpretation of refraction tomography gave information about the elastic properties of rocks building the near-surface zone. As the research area was located in a well-known geologically and seismically zone, it was possible to verify the results and evaluate the methodology adopted for the processing and interpretation of electromagnetic and geoelectric data.

Conclusion

The presented materials gave a new view on the possibilities offered by the engineering geophysics methods in the recognition of geological structure and the assessment of the tectonic involvement of this zone related to exploration works. Such data sets may be helpful in interpreting the results of reflection seismic data processing, where problems with the proper attribution of lithology and geometry of rocks in the shallow zone often occur. This is mainly the case in areas where there is significant weathered zone, there is only sparse drilling information and where there are not enough outcrops.

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References

Cygal A., Stefaniuk M., Kret A., Klityński W., 2015. Zastosowanie metody konduktometrycznej do typowania stref o zmiennych parametrach filtracyjnych w obrębie podstawy wału przeciwpowodziowego — Application of the conductivity methods to select zones with variable filtration parameters around the base of river levee. Przegląd Geologiczny ; ISSN 0033-2151. — 2015 t. 63 nr 10/1, s. 652–656. — Bibliogr. s. 656, Abstr.. — WPH 2015 : XVII Sympozjum Współczesne Problemy Hydrogeologii : Ustka, 20–23.10.2015 r.

Cygal A., stefaniuk M., Kret A., Kurowska M., 2016. The application of electrical resistivity tomography (ERT), induced polarization (IP) and electromagnetic conductivity (EMC) methods for the evaluation of technical condition of flood embankment corpus. Geology, Geophysics & Environment, Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie ; ISSN 2299-8004. — Tytuł poprz.: Geologia : kwartalnik Akademii Górniczo-Hutniczej im. Stanisława Staszica w Krakowie ; ISSN: 0138-0974. — 2016 vol. 42 no. 3, s. 279–287. — Bibliogr. s. 286–287, Abstr.. — tekst: https://goo.gl/EURiVo.

Stefaniuk M., Cygal A., Sada M., Kret A., Lewiński G., 2015. Złoże ropy naftowej Wańkowa w interpretacji danych elektromagnetycznych — The ”Wańkowa” oilfield in electromagnetic data interpretation. Nafta Gaz, Instytut Górnictwa Naftowego i Gazownictwa, Instytut Technologii Nafty, Stowarzyszenie Inżynierów i Techników Przemysłu Naftowego i Gazowniczego ; ISSN 0867-8871. — 2015 R. 71 nr 9, s. 673–680. — Bibliogr. s. 680.

Wojdyła M., Stefaniuk M., Sada M., Sito Ł., 2011. Metoda polaryzacji wzbudzonej w prospekcji złóż węglowodorów/ Induced polarization method in hydrocarbon prospecting. GEOLOGIA 2011, Tom 37, Zeszyt 1, p63–88.