SEISMIC RESERVOIR CHARACTERIZATION FOR RECOGNITION OF GEOTHERMAL PARAMETERS

Anna WACHOWICZ-PYZIK, *Anna SOWIŻDŻAŁ, Tomasz MAĆKOWSKI, Michał STEFANIUK

*AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Department of Fossil Fuels, al. Mickiewicza 30, 30-059 Krakow, Poland; *ansow@agh.edu.pl*

Abstract

Seismic methods widely applied by petroleum industry for exploration of conventional and unconventional (shale gas/oil, tight gas) hydrocarbon deposits are more and more common applied to studies of geothermal resources. Taking into account geological risk, related with location of wells for geothermal purposes, seismic methods can significantly improve the recognition of geological structure of water horizon. Furthermore, such methods can be useful in determination of hydrogeothermal parameters of particular aquifer. Authors presents advantages of seismic methods implementation for geothermal purposes on example carried out in Mogilno-Łódź Trough.

Introduction

Seismic methods are not commonly used as a tool for geothermal purposes. In Poland first implementation of seismic method, in the geothermal field, was cooperation between Polish oil industry and the Institute of Fossil Fuels of the AGH University of Science and Technology in Kraków, in 1987 year. Under the contract the 2D seismic survey in the Skoczów-Wadowice-Sucha area were extended for 6 seismic sections localized in the Podhale Depression. Thus obtained data for positioning of the wells: Biały Dunajec PAN-1, Poronin PAN-1 and Nowy Targ PIG-1. In the years 2001/2002, the 3D seismic survey was run for the Geotermia Podhalańska Company (Czerwińska, 2014). The low rate of seismic methods utilization in geothermal projects is associated with problems of implementation the seismic methodology to geothermal issues. An important factor in this case are seismic profiles made for recognition of hydrocarbon deposits, which are generally not optimal for geothermal purposes. Furthermore the measurement methodology used in case of older seismic profiles were focused to better determination of oil and gas traps located deeper than shallow geothermal aquifers. Also the high costs of seismic survey significantly limits the seismic method implementation in geothermal industry. On the other hand, the possibility of use the archival seismic data in the case of geological structure recognition, determination of geometry of geothermal aquifers and distribution of hydrogeothermal parameters significantly affect the possibility of geothermal potential recognition. The advantages of seismic methods implementation for geothermal purposes were presented in Mogilno-Łódź Trough.

Mogilno-Łódź Trough

Mogilno-Łódź Trough is located in the central part of the Polish Lowland, which is recognized as the most perspective area in Poland for geothermal resources utilization. The potential of Polish Lowland was the subject of many research project in recent years (see e.g. Górecki, (Eds.) et al., 2006a;b; Wójcicki, Sowiżdżał, Bujakowski, Tomaszewska (Ed.) et al., 2014; Górecki et al., 2015; Sowiżdżał et al., 2017; Kępińska et al., 2017; Sowiżdżał, 2018), all of them confirm the possibilities of geothermal water utilization in Lower Cretaceous and Lower Jurassic aquifers. The area of Mogilno-Łódź Trough was also used for geothermal parameters evaluation from the results of seismic survey (Maćkowski et al. 2019, Sowiżdżał et al. 2019). The results enabled to determine the geometry of the geothermal aquifer (Fig. 1). The good quality of seismic imaging, in the shallow part of the newest seismic sections in the interval of Cretaceous and Jurassic measures occurring (up to 1000 [ms]), clearly indicated that the Lower Cretaceous aquifer remains tectonically undisturbed. Based on seismic inversion the porosity of reservoir rocks was determined. The results showed that the porosity and the thickness increase within the anticlinal elevation and that the trend of favourable reservoir properties (porosity over 20%) continues in the deeper parts of the aquifer. Due to the

higher temperatures of the water the most perspective area for future investments in geothermal installations could be pointed out.

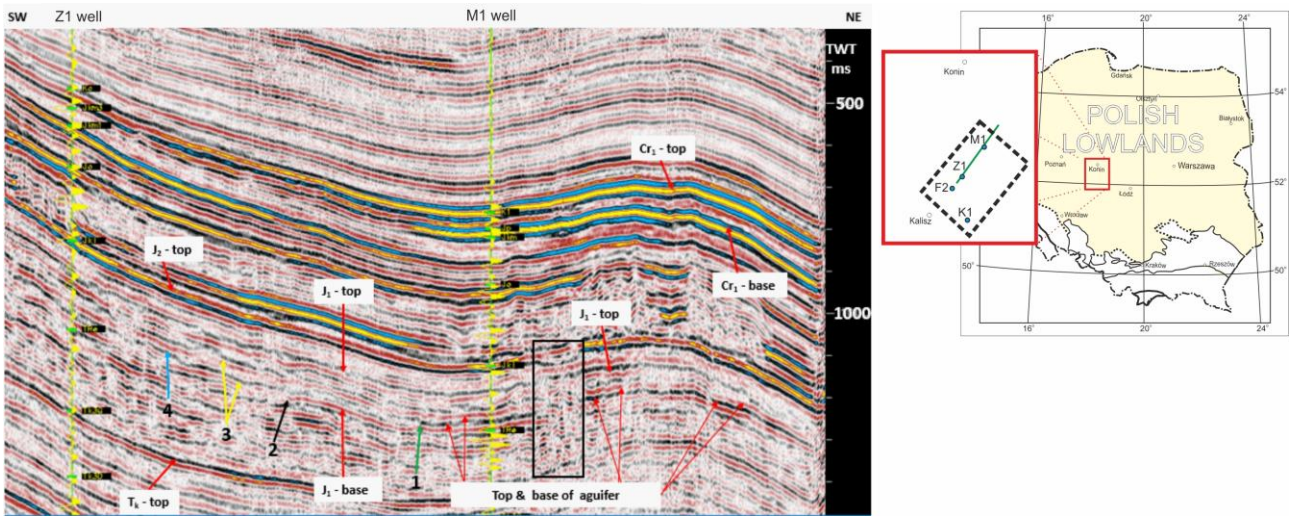

***Figure 1**. A fragment of time section of seismic profile localized in the vicinity of M1 and Z1 wells (thick green line on the map). Explanations: negative reflections amplitudes: yellow – very high, red – high, light red – low and very low; positive reflections amplitudes: blue – very high, black – high, light black – low and very low; yellow plots – synthetic seismograms; black rectangle – zone of increased noise and reflections distortion caused by a reef body in the overburden. Arrows: green, No.1 – range of groundwater horizon of parameters identified in the M1 well, black, No. 2 – weakening of reflection (towards the SW) related to bottom stratigraphic boundary of Lower Jurassic formation, yellow, No. 3 – thickness increase of groundwater horizon, blue, No. 4 – thickness decrease of groundwater horizon towards the SW. Black rectangle – dislocations (Sowiżdżał et. al., 2019, modified).*

Conclusions

Seismic methods can be applied for determination of hydrogeothermal parameters, which determined the possibility of geothermal water utilization. They can be also successfully used for recognition of geological structure and determination of geometry of geothermal aquifers, to characterization of dislocations or to imaging the heterogeneity of geothermal aquifers. Moreover, the reinterpretation of archival seismic data is not related to the additional costs of field research and can significant improve recognition the distributions of hydrogeothermal parameters which they determine the location of potential investments.

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