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Geothermal Conditions of the Lódz Synclinorium Early Creataceus Reservoir

Pawel Wojnarowski, Aneta Sapinska-Sliwa and Tomasz Sliwa

AGH University of Science and Technology; Al. Mickiewicza 30; 30-059 Krakow, Poland

wojnar@agh.edu.pl, ans@agh.edu.pl, sliwa@agh.edu.pl,

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ABSTRACT

The Early Creataceus aquifer is a large sedimentary structure in the Great Poland depression. Lódz Synclinorium is located in the center of this structure, where many boreholes have been drilled during long period for geological research as prospecting wells. Geothermal water has been found by the way of potential hydrocarbon level testing.

Some towns which are located in this area might be consumer of produced geothermal energy for space heating and recreation purposes. Among them is the second biggest polish city Lódz, with over 800 thousand inhabitants. Moreover, one geothermal plant in this area operates since 2000. In this work main reservoir properties were analyzed and perspective areas were indicated.

1. INTRODUCTION

During last years, interest for geothermal development in Poland is growing. This interest is driven by the good geothermal conditions present in Poland and by environmental pressure to reduce use of fossil fuels in thermal plants.

In the Polish territory occur three main European geotectonic elements: East-European Precambrian platform, West-European Palaeozoic platform and the Alpine orogenic area (Figure 1). Heat flow is low to moderate and its value is 40 – 90 mW/m2 while geothermal gradients amount to 2 – 3 oC/100 m (Kepinska 1998). Over 80 % of the Polish territory is built of Mesozoic-Tertiary sedimentary basins with numerous aquifers. This is often called the Great Poland Depression.

Among the numerous sedimentary layers of the Great Poland Depression, the so called Early Cretaceous aquifer is of special interest. It is almost entirely bounded by outcrops. Only the NW and E edges extend beyond the state borders. The Early Cretaceous aquifer layers (permeable sandy and sandy-muddy sediments) belong mainly to the Valanginian, Hauterivian, Middle Barremian – Aptian and locally to the Albian stages in geological time. The variable lithology of the Early Cretaceous strata and local incorporation of permeable Upper Albian and Cenomanian sediments, result in highly irregular thickness of the permeable horizon. (Wojnarowski 2000).

2. GEOLOGICAL INVESTIGATION OF THE LODZ SYNCLINORIUM

The Lodz Synclinorium is located in central Poland (Figure 1). Several cities in the central part of the synclinorium may benefit from the utilization of geothermal water from the Early Cretaceous aquifer. The Lodz Synclinorium is the south part of the Szczecin – Mogilno – Lodz Synclinorium, situated in the Great Poland Depression. To the NE the Lodz Synclinorium is limited by Pomorze - Kujawy Antyclinorium and to the SW by Fore-Sudetic Monocline.

Figure 1: Tectonic subdivision of Poland (Sokolowski et al. 1992)
A — Pre-Cambrian Platform area
B — Great Poland Depression
C — The fold-block area
D — Carpathian Mts. (Alpides)
E — Neogene Carpathian Foredeep

There are presently being conducted few geothermal research projects in order to utilize the deep geothermal water for district heating. There is also one working geothermal plant in the town of Uniejow. It concerns hot water production from the Early Cretaceous sandstones, containing water of 70 °C temperature. Water is produced from an geothermal well, for space heating and after cooling is injectet into reservoir. It is also possible to utilize geothermal water from this reservoir in several other towns, in particular the towns of Lódz, Kolo and Poddebice.

Information on the hydraulic parameters of permeable and semi permeable rocks is rather limited as the Early Cretaceous reservoir has not been a subject of interest and large scale exploitation. Exceptions are however at the outcrops to the NE margins of the Lodz Synclinorium and, to some extent, in other sedimentary units where fresh groundwater is exploited. Hydraulic parameters have therefore mostly been measured for the shallower parts of the aquifer, close to the outcrops. In these the reservoir temperatures are naturally too low for any substantial geothermal applications. The geothermal aquifer hosted in the Early Cretaceous sedimentary unit is at confined conditions throughout almost the whole area. Unconfined conditions occur only in the outcrops and incrops under the Cainozoic (mostly Quaternary) deposits. Pressure in deep wells suggests the existence of regional flow within the

Early Cretaceous aquifer with the flow direction generally from SE to NW (Gorecki et al. 1995).

Information available on the Early Cretaceous geothermal aquifer come mostly from oil and geological exploration drilling made by both the local petroleum industry and the State Geological Institute. The irregular borehole pattern and limited range of measurements and core sampling result in limited hydrogeological characterization of the reservoir. Well tests have been performed in a fraction of the boreholes, mainly in shallow wells at outcrops and incrops, but also in the most recent deep wells. In some cases parameters like open porosity and specific surface have been determined in laboratories from core samples.

3. GEOTHERMAL CONDITIONS OF THE LODZ SYNCLINORIUM

Aquifer parameters like permeability, thickness and temperature vary in space. A study of the Lodz Synclinorium spatial distribution of reservoir parameters, using geostatistical methods was made. These studies resulted in maps of depth to aquifer, its thicknes, permeability and temperature. These maps are presented at figures 2 - 5.

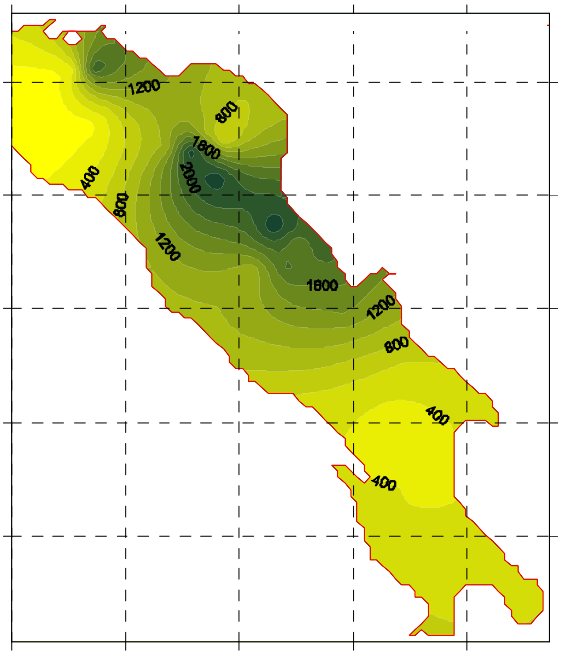

Figure 2: Top of the Early Cretaceous reservoir in the Lodz Synclinorium [m.u.s.l.].

The Early Cretaceous reservoir in the Lodz Synclinorium is part of a wide permeable structure. It has the shape of a long syncline striking SE – NW. The deepest part of the aquifer is in the centre of synclinorium (figure 2). The depth is about 2000 m.u.s.l. The temperature varies from about 10-15 °C on the outcrops to about 70 °C in the deepest part of the reservoir (figure 5). Thickness of the aquifer is variable. It changes from few meters, to about 200 meters maximum (figure 3). The Early Cretaceous sandstones characterize very high permeability. It reach about 4 darcy in centre of structure (figure 4).

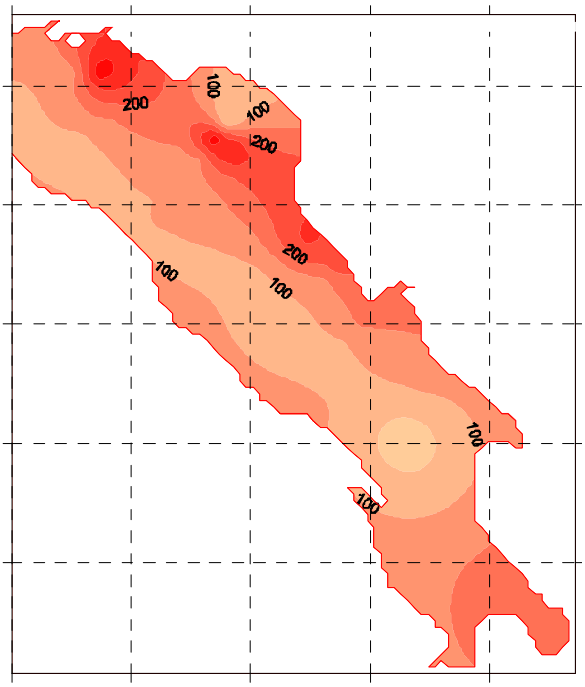

Figure 3: Thickness of the Early Cretaceous reservoir in the Lodz Synclinorium [m].

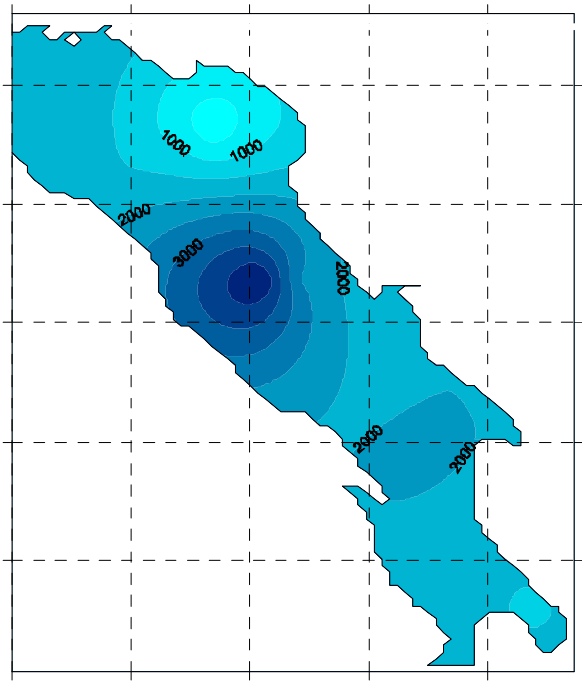

Figure 3: Permeability of the Early Cretaceous reservoir in the Lodz Synclinorium [mili darcy].

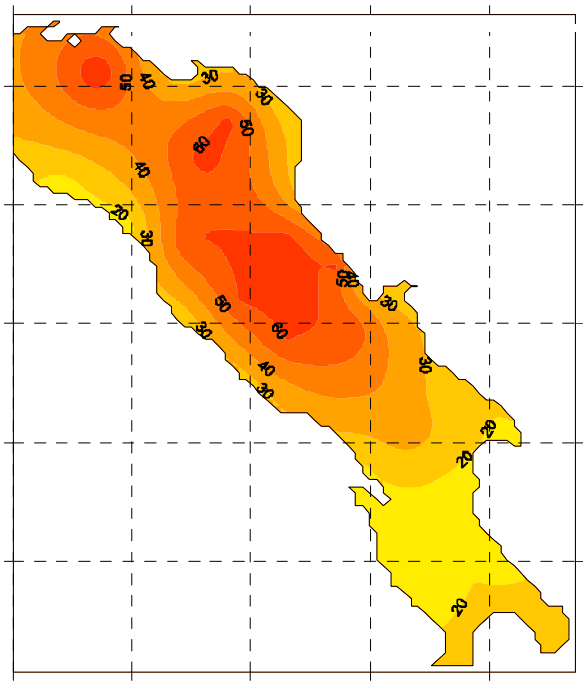

Figure 3: Temperature distribution in the top of the Early Cretaceous reservoir in the Lodz Synclinorium [°C].

4. GEOTHERMAL CONDITIONS IN UNIEJÓW

Resources of geothermal water in the region of Uniejów occur in the lower Cretaceous sandstone at a depth of 2000 m. Temperature of water at the production well head reaches 70 ^{o}C. Flow rate in the condition of water self outlet reaches about 68 m^3/h. Water have been classified as sodium chloride, fluoride water, boron water with mineralization of approximately 6.8 – 8.8 g/dm^3 depending on well.

It was necessary to reconstruct injection wells upon investing into geothermal heating systems. This was made at the end of 2000 thanks to the support of the National Fund for Environmental Protection and Water Management in Warsaw. The aim of the said reconstruction was obtaining technological and economically advantageous conditions for injection water into the reservoir. As a result, positive parameters of geothermal water injection were obtained, pressure 7.1 bar at the flow rate corresponding to the self outlet productivity.

The exploitation of geothermal water for heating purposes circulates in a closed cycle. Geothermal water is produced from the well Uniejów PIG/AGH-2 and after going through heat exchanges and transferring heat to heat carrier, it is directed to the same water-bearing layer through the injection well Uniejów PIG/AGH-1. The hydraulic contact in the deposit was confirmed by hydrogeologic tests carried out in winter 2000/2001 (Sapinska-Sliwa 2003).

At present, chilling water is injected to the injection well Uniejów PIG/AGH-1 at the appropriate economical and pressure parameters of injection. However, taking into account the chemical composition of brine as well as the planned growth in the use of Uniejów geothermal water for the needs of balneotherapy sanatorium, the third borehole should be considered as an additional injection well, e.g. well Uniejów IG-1. Its location is advantageous and due to a relatively small distance from the present well injection site.

There were also conducted researches on geothermal water for therapeutic purposes. They proved to have a beneficial influence on health. Besides, they can be used for recreation and balneotherapy purposes.

Works on the geothermal system heating started at the beginning of 2000 and lasted to the end of 2001. In the framework of the geothermal investment, ten kilometers long heating pipelines have been lied out and addition installments have been made. Geothermal district heating extends from public buildings, e.g. school, teacher's house, kindergarten, church, presbytery, health center, chemist's, block of flats and two detached houses estates. About 170 new customers were linked to the system.

A heating central using geothermal water energy of 3.2 MW was constructed. In the heating plants, oil boilers of 2.4 MW were installed as a peak load heating source.

The geothermal energy coming from water is presently used for central heating and heating of tap water. Tap water that is used for private and public residential buildings is produced in the heating plants. The maximum production of tap water is determined by total heating power of heat exchangers. It reaches up to 0.4 MW (Sapinska 2000).

4. CONCLUSIONS

The Early Cretaceous reservoir in the Lodz Synclinorium can be used as a source of geothermal water with temperature up to 70 °C, which can be utilized for central heating. The localization of several towns in this area can provide heat consumers. Moreover neighborhood of large city agglomeration as Lodz get possibility to utilize geothermal water for recreation.

The Geotermia Uniejów Ltd. is the first heating plant that supplies energy to the recipients in a very small town. The experience gained at the investment and exploitation stages should be properly used. This is connected with additional costs resulting form the innovation character of such investments in the Polish conditions.

The condition of effective consumption of geothermal heat is taking away the biggest quantity of energy from geothermal water. The project should point to the cascaded use of heat. Therefore, at the beginning of the project one should consider using energy for heating buildings than for other purposes required lower temperatures like balneotherapy, swimming pools, glass houses or acquaparks (that are still not very popular now.)

Because of their localization, big cities are more advantageous for geological investments. A significant majority of recipients could be public and group recipients. In order to work out a reliable study of real profits coming from the heat sale, only public and individual recipients who declared their wish to be connected to a new chain should be analyzed at the beginning of preparing the project.

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