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Exploration of Deeper (2-5 km) Geothermal Energy Resources in Hungary

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ABSTRACT

The exploration of deep geothermal resources in a sedimentary basin requires new concepts. From a geological point of view, different approaches are needed in the cases of fractured carbonate and sandstone rocks. In carbonate rock, the main challenge is the determination of production well locations, while in sandstone, the most exciting question is reinjection. With respect to thermal energy, the optimal depth must be determined in every site where the temperature is high enough and there is still an appropriate thermal water flow-rate. In the Pannonian Basin, the geothermal exploration of deeper resources is in its early stages. However, MOL and its international affiliate, CEGE Ltd., have several years of experience in this field. The results of this geothermal exploration activity are described here.

1. COMPLEXITY OF THE EXPLORATION STRATEGY IN A SEDIMENTARY BASIN

The establishment of geothermal energy production units in a sedimentary basin is a complex process that requires a structured approach. The complexity can first be observed in the technical challenges, and the earth science and energy tasks should be handled in a parallel way.

Earth science exploration is itself a compound task that involves geological studies, geophysical acquisitions, and drilling activities. By deepening wells, we can discover thermal water reservoirs in many deep sections that can be exploited according to their temperature and yield. During the design of the surface technology, the demand of all possible consumer segments must be met, and the reduction of carbon-dioxide emissions should be taken into consideration. The wide range of national and local consumers and the opportunity for carbon-dioxide emission reduction are the two main driving forces in the creation of geothermal exploration strategy.

The location and size of thermal water reservoirs clearly have no regard for county or state borders, so international co-operations are often needed.

Project risks must also be intricately considered, because regulatory, financial, and technical risks can all emerge. The complexity of risks is the main restraining force in the creation of geothermal exploration strategy.

Based on this type of complex approach, micro, small, and medium size geothermal power plants as well as direct heat units that satisfy all sorts of heat demand can be established in sedimentary basins. Moreover, the utilization of ground heat pumps should also be considered in every project.

2. TECHNICAL CHALLENGES AND OPPORTUNITIES

There are more than 8000 hydrocarbon wells in Hungary, the majority of which are abandoned and some of which produced thermal water instead hydrocarbons. Therefore, the underground technical concept can include the utilization of existing hydrocarbon wells for producing and reinjecting thermal water. However, the exact flow rate is yet to be determined because the exploration drilling was initially focused on hydrocarbons, and thermal water production and reinjection tests are necessary.

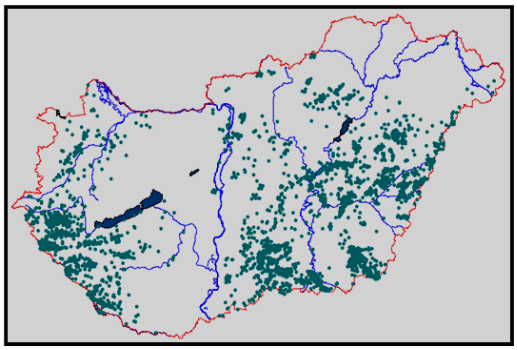

Figure 1: Distribution of hydrocarbon wells in Hungary

With respect to thermal energy, the key issue is the determination of the thermal heat capacity that the different sites are able to produce. The geothermal resources of the Pannonian Basin in Hungary are described in Table 1. The goal of exploration of deep zones is to discover reservoirs that are able to supply thermal heat for power plants.

Table 1: Geothermal Power Plant Establishment Technical Concept set for 2020 in Hungary

Power Plant Model MW_e	Depth range in the Pannonian Basin (m)	Reservoir temperature range (^oC)	Áverage capacity (MW_e)	Estimated number of Reservoirs	Total capacity (MW_e)
5 - 12	> 3500	160 - 200	8	3	24
2 - 5	2000 – 3500	120 - 160	3.5	8	28
max. 2	< 2000	< 120	1	8	8
				Total	**60**

3. EXPLORATION ACTIVITY OF DEEP ZONES IN HUNGARY

The geothermal potential of the Pannonian Basin is well above the world average, and, except the active volcanic areas, it is one of the most prospective territories in Europe. In spite of this, geothermal energy is only utilized on a small scale in Hungary, and those few are operated in a less environmentally sound way (not reinjecting the 100% of the produced water into the reservoir). Further, no geothermal power plant facility exists in the country.

MOL Hungarian Oil & Gas Plc. decided to establish a team to develop a Geothermal Pilot Project to explore power plant opportunities offered by the geothermal resources in Hungary. This team analyzed potential geographical locations where the volume and heat of extracted water would be adequate for a geothermal power plant. The Pilot Project has been set up with investor partners. In March of 2006 MOL, Enex of Iceland and Vulcan Kft. (its owner is Green Rock, Australia) established a consortium in which MOL was the operator.

The Pilot Project well completions began in southwestern Hungary in December 2006, and well tests were performed in 2007. During the testing phase, two currently out-of-order hydrocarbon wells were converted into thermal water production or reinjection wells. Thermal water was extracted from the wells into a 2000 m^3 pit near the well. Then, the produced thermal water was reinjected back into its own aquifer through the same well.

A new approach in Hungarian geothermal exploration is highlighted by the utilization of abandoned hydrocarbon wells, the establishment of an international consortium for thermal water exploration, the unusual depth, the fairly high temperature (in the European continent), and the focus on power plant establishment. The MOL-Enex-GreenRock pilot project began a new segment in Hungarian geothermal exploration history. The main characteristics of this new segment are:

- deeper wells (2-4 km)

- higher temperature (120-170^{o}C)

- reinjection of 100% of the produced thermal water into its own reservoir.

The production of thermal water into a pit is shown in Figure 2. The water was produced from a 3000 m depth and was reinjected into the same reservoir.

The consortium partners declared that their geothermal strategy is working and decided to widen their co-operation. In 2008, they established a joint company, CEGE Central-European Geothermal Energy Production Private Company Ltd. The mission of this geothermal company is to be a market leader in geothermal energy production in Hungary; therefore, this company must face all the challenges inherent to Hungarian geothermal energy exploration.

4. SUMMARY

The geothermal potential in sedimentary basins is generally not as high as that in active volcanic areas. Therefore, in countries located in sedimentary basin areas, the geothermal energy exploration of deep zones (2 – 5 km) is also required.

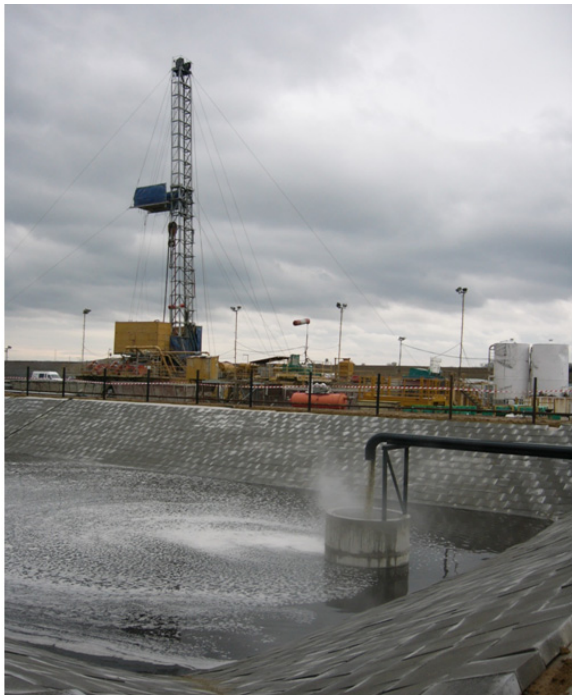

Figure 2: Testing existing hydrocarbon wells in southwestern Hungary

The geothermal exploration of deep zones in sedimentary basins is a complex process in which all difficult technical, financial, and risk management issues must be taken into consideration. Therefore, a complex strategy must be created before the launching the geothermal exploration in the Pannonian Basin.

The significance of the described MOL-Enex-GreenRock well-testing program is that it was the first “Pilot Project” in Hungary aiming for direct geothermal exploration below 3000 m depths. The analysis of the results of these well tests can be a stable basis for the energy exploration of deep geothermal zones in Hungary.

REFERENCES

Bobok, E, (1995) “Geotermikus energiatermelés (Geothermal Energy Production)” Miskolc University manuscript, Hungary, pp.87-96.

DiPippo, R, (2005) “Geothermal Power Plants” Elsevier, pp. 21-78.

Kujbus, A, (2009) “Hydrocarbon Well Testing as Part of Geothermal Exploration in Hungary” *Proceedings*, 34th Workshop on Geothermal Reservoir Engineering, Stanford University, USA.

Tóth, A, (2004) “Geotermikus energiatermelő rendszerek hőmérsékletviszonyai (Temperature in Geothermal Production Systems), PhD Thesis”, Miskolc University, Hungary, “Heat Extraction from Abandoned Wells” pp. 64-75.

Ungemach, P, (2003) “Reinjection of Cooled Geothermal Brines into Sandstone Reservoirs” Geothermics 32, pp.743-761.