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SUCCESSFUL INJECTION OF GEOTHERMAL WATER INTO SANDSTONES – AN EXAMPLE FROM HUNGARY

ABSTRACT

In 2011 a new geothermal district heating system was established in Orosháza-Gyopárosfürdő (SE Hungary) using one production and two injection wells. This system is one of the few successful re-injection projects in Hungary targeting the problematic Upper Pannonian sandstones. Despite the similarity of the wells, their injectivity differs greatly. This paper presents some recent results and phenomena occurring during the injection of spent geothermal water back into a reservoir via two injection wells.

KEY WORDS

Geothermal water, injection, Upper Pannonian sandstones, Hungary

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1. OROSHÁZA-GYOPÁROSFÜRDŐ GEOTHERMAL DISTRICT HEATING SYSTEM – MAIN DATA

At the end of 2011, a 1 MW geothermal district heating system became operative at the Gyopásfürdő Thermal Park and Adventure Spain in Orosháza-Gyopárosfürdő, a small town located in the south-eastern part of the Hungarian Great Plain.

Fossil fuel use at the Orosháza-Gyopárosfürdő spa has been substituted in 100% by geothermal energy using 88°C geothermal water produced from an Upper Pannonian (i.e. Upper Miocene and Pliocene) sandstone reservoir at a depth of around 1500 m, and re-injected through two injection wells into the same aquifer. The investment was realized by a consortium established by 3 Hungarian companies, two of which were the VIKUV cPlc. responsible for drilling the wells and the Porció Ltd. implementing the surface constructions (laying 2 km of isolated geothermal and 900 m of isolated district heating pipeline and creating the geothermal system consisting of mechanical, electrical, and remote control

units). The investment was subsidised by the European Union via the Environment and Energy Operative Programme (Szita, Vitai 2012a).

2. THE INJECTION WELLS

This system in Orosháza-Gyopárosfürdő is unique in terms of the injection since it is one of very few systems in Hungary where re-injection is successful into Upper Pannonian sandstones. Moreover, the fact that the injection works only through one of the injection wells and hardly at all through the other – although the targeted layers are the same – makes the system even more unique. Until June 2013, water legislation in Hungary mandated the injection of energetically utilised thermal waters into the same aquifer as they were taken from. In Gyopárosfürdő the system was developed fully according the law: the parity of the used layers is proven by water and gas analysis and their geological description. Figure 1 shows the water chemistry of the wells (T4 stands for the production well, V1 and V2 are the injection wells) indicating the same origin of their waters (standard deviation of the data is below 10%). The gas content varies a bit more but also shows a close similarity (Figure 2).

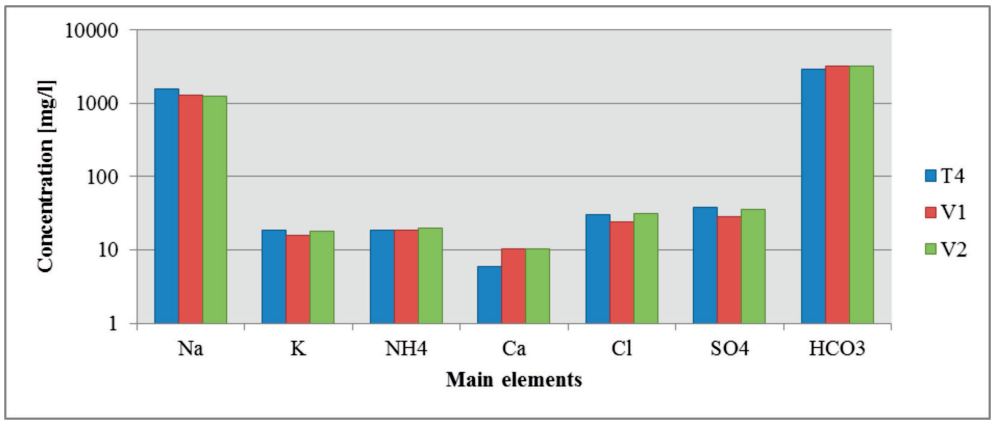

Fig. 1. Chemistry of geothermal water exploited by Gyopárosfürdő T4, V1, V2 wells

Rys. 1. Chemizm wody geotermalnej eksploatowanej przez otwory T4, V1, V2 w Gyopárosfürdő

With regard to the geology, the description of cuttings taken while drilling is basically the same for all the sandstone layers in the wells: grey, loose, medium sized, well sorted, well rounded, highly calcareous quartz sandstones and grey, partly cemented, fine and very fine grained, highly calcareous, silty sandstones alternate with clay layers. Figure 3 and Figure 4 showing the thickness variations of the sandstone layers were created by interpolation of the well data.

A month after the system started in 2011, an interesting phenomenon occurred. The wellhead pressure at the injection well V1, which had previously been approximately 2 bar

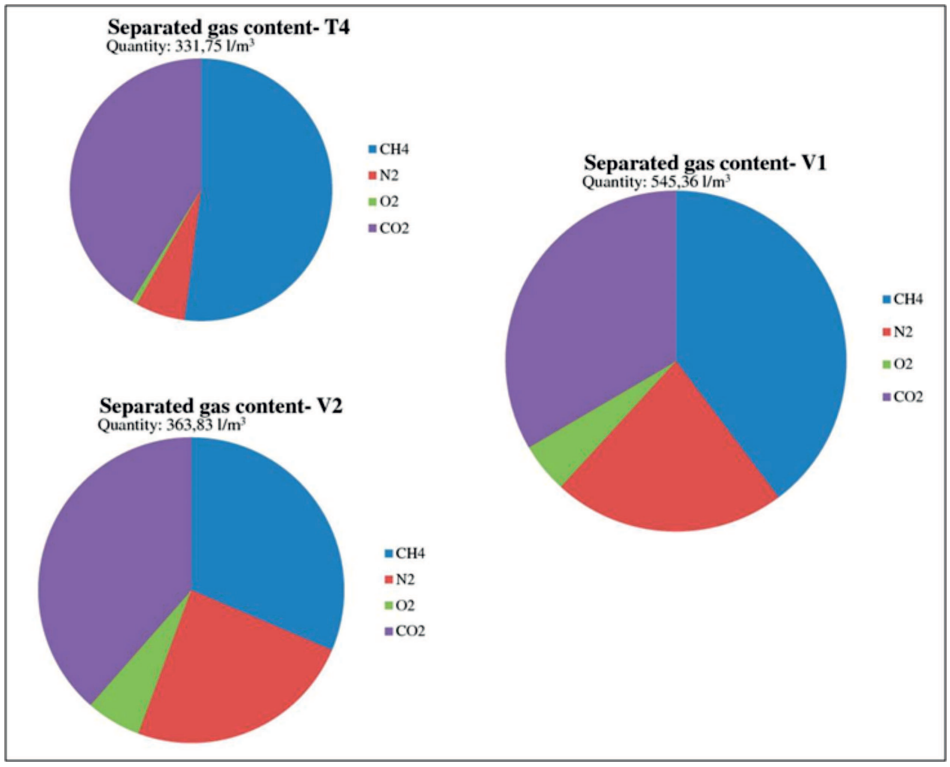

Fig. 2. Gas analysis of geothermal water from Gyopárosfürdő T4, V1, V2 wells

Rys. 2. Analizy gazów zawartych w wodzie geotermalnej eksploatowanej otworami T4, V1 I V2 w Gyopárosfürdő

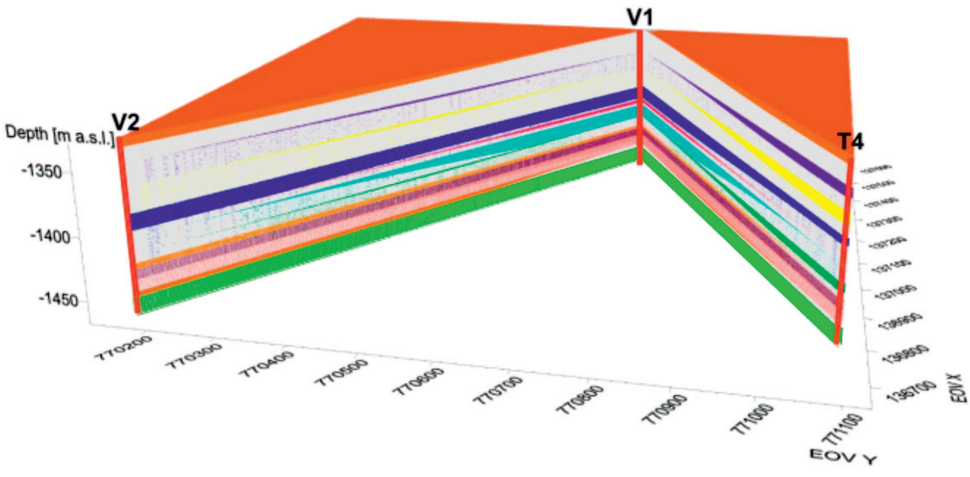

Fig. 3. Gyopárosfürdő geothermal wells T4, V1, V2 and their screened layers

Rys. 3. Otwory geotermalne T4, V1 I V2 w Gyopárosfürdő i zafiltrowane warstwy

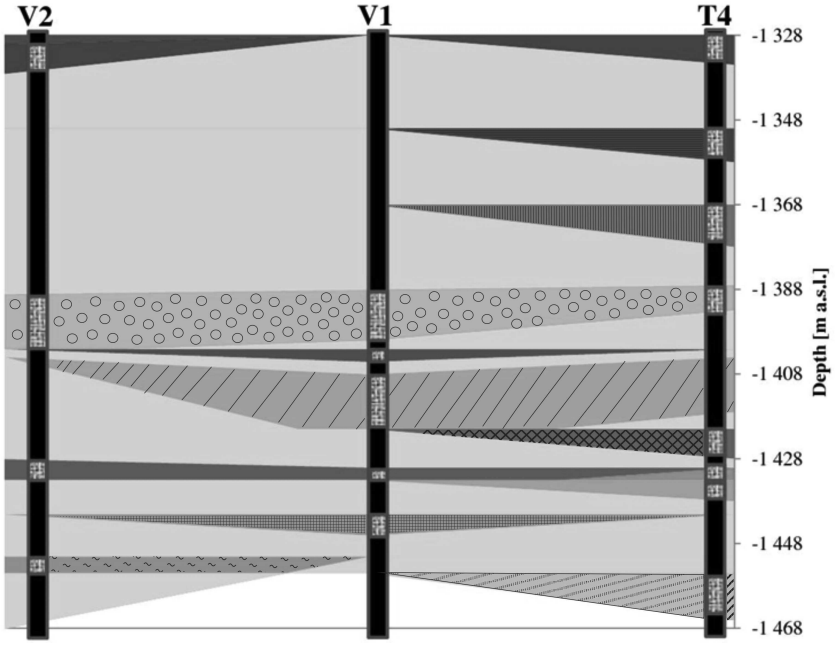

Fig. 4. Gyopárosfürdő T4, V1 I V2 wells: screened layers in 2D

Rys. 4. Otwory geotermalne T4, V1 I V2 w Gyopárosfürdő: zafiltrowane warstwy pokazane w 2D

higher than that at well V2, suddenly started to decrease and has been around 0 bar-g since then (or even lower) (Figure 5). The cause of this was hypothesized as follows (Szita, Vitai 2012b):

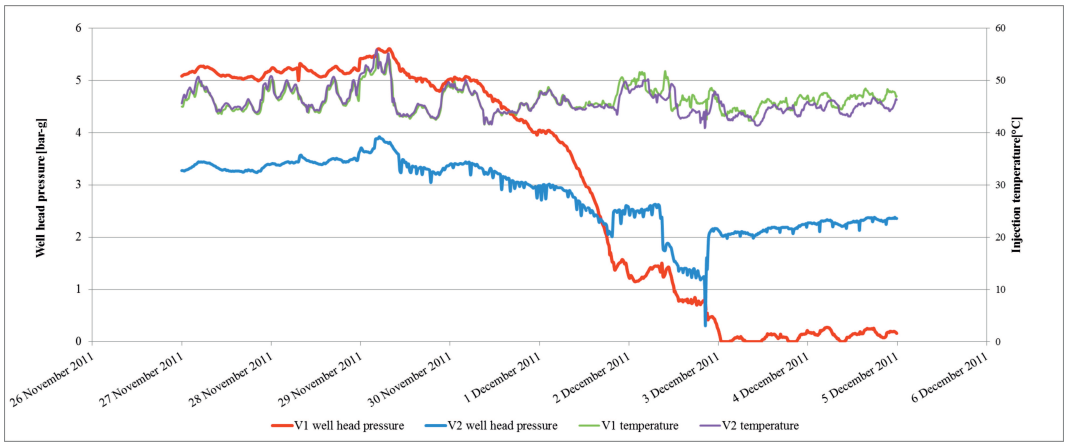

Fig. 5. Gyopárosfürdő: wellhead pressure drop at the well V1during geothermal water injection

Rys. 5. Gyopárosfürdő: spadek ciśnienia głowicowego w otworze V1 podczas zatłaczania wody geotermalnej

– because of a well structure failure, the utilised thermal water may not be re-injected into the same aquifer in both of the wells,
– the layers have been riven and the continuous injection has maintained the fracture systems and therefore the injectivity.

To exclude the first possibility, the drilling company VIKUV cPlc. analysed the flow conditions inside the wells, which helped to confirm the stability of the well structure. The second possibility was, on the other hand, supported by the observation that the well head pressure was slightly lower at higher injection rates, which may mean that greater water quantity can keep fractures open. However, a comforting explanation for the issue has not yet been found. That is why continuous measurements are conducted in the hope that the answer will soon be found.

CONCLUSIONS

It is frightening to imagine what would have happened if only one injection well had been included in the Gyopárosfürdő project: had it been well V2, the project would have failed. Based on the almost 2-years of operational experience at Gyopárosfürdő, the question is inevitable whether the injection into Upper Pannonian sandstones in Hungary is entirely dependent on good fortune. The answer is certainly no. Nevertheless, it is certain that we in Hungary still do not possess the proper knowledge of re-injection phenomena which would be indispensable for making good legislation regarding geothermal operations.

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UDANE ZATŁACZANIE WODY GEOTERMALNEJ DO PIASKOWCÓW – PRZYKŁAD Z WĘGIER

STRESZCZENIE

W 2011 r. oddano do użytku nowy system geotermalnego centralnego ogrzewania w Orosháza-Gyopárosfürdő (SE-Węgry), który użytkuje jeden otwór produkcyjny i dwa otwory chłonne. Jest to jeden z niewielu systemów na Węgrzech, w których z powodzeniem prowadzone jest zatłaczanie wody geotermalnej do piaskowców górnego panonu, sprawiających na ogół problemy w tym zakresie. Pomimo podobieństw otworów chłonnych, ich chłonności różnią się w znacznym stopniu. W tym względzie w artykule przedstawiono niektóre najnowsze wyniki i zjawiska zachodzące podczas zatłaczania dwoma otworami chłonnymi wykorzystanej wody geotermalnej do piaskowców zbiornikowych.

SŁOWA KLUCZOWE

Woda geotermalna, zatłaczanie, piaskowce górnego panonu, Węgry