Analytical and numerical evaluation of pumping test data in carbonate aquifers of the Buda Thermal Karst, Hungary

Tamás Garamhegyi, Judit Mádl-Szőnyi, Ferenc Székely

Eötvös Loránd University, Budapest, Hungary (garam999@gmail.com)

The revision of archive well hydraulic data is significant for regions where limited pumping test data are available, like the area of Budapest. Interpretation of hydraulic parameters (T, S) based on well tests may be used as input data in hydrostratigraphic evaluation of the rock framework for numerical simulation. The geological logs and documentations of the pumping test data were collected and digitalized for thermal wells of the area of Buda Thermal Karst.

The modern hydrogeology defines the representative elementary volume (REV) for which the hydraulic parameters have to be considered as constant. Since that it has known that the value of hydraulic parameters depends on the scale of the examination. The carbonate aquifers can be characterized from fractured to hierachical permeability structures. Therefore their hydraulic conductivity highly depends on the scale of the evaluation.

Different methods can produce T, S values which are representative for different volume of rock. Short term pumping test can produce values for the limeted zone in the surroundings of wells, while long term pumping data can be representative for the bigger rock volume. For carbonate aquifers with high level of heterogenity the representativity of the data derived from pumping test is highly depends on the length of pumping tests (Király, 1975).

The goals of the study were the re-evaluation of the pumping test data for the carbonate aquifer system of Buda Thermal Karst: i) to compare the parameters derived from single pumping test data and an interference test; ii) to evaluate the effect of double porosity of carbonate aquifers on hydraulic parameters (K, T and S); iii) to compare the efficiency of analitical and numerical methods in the evaluation.

The processed data series were partly short term recovery tests which originate from well tests during establishment of new wells. In the second part of the evaluation a unique large-scale long term interference test was reinterpreted, which were performed after establishment the Pascal thermal well in 1966 (Böcker, 1966).

Classical analytical and numerical methods were used respectively. The applied analytical method based on the Theis-Jacob recovery test and for the evaluation the Aquitest sofware was used. The Visual Two-Zone model and the WT model (Székely, 2006) were applied for numerical simulation of the data for the carbonate sequence. These softwares handles the heterogenity as anisotropy. The derived hydraulic parameters from analytical and numerical solutions and from short and longer term tests were compared in the study.

The significance of the research is that the available data of thermal wells for the area of Budapest were re-evaluated. During the research 21 single well pumping test data series were analysed. However in several cases the missing records of the measurements made the evaluation impossible. The revision was made with the Cooper-Jacob analytic method in local and regional scale (Pascal long term pumping test) too. Finally numerical simulation was used for 4 wells to obtain the required hydraulic parameters (Fig. 1). As a conclusion of the study the Upper Triassic Dolomite (Hauptdolomit) can be characterized by $K_h=10^{-5}$ m/s, $K_v=10^{-2}$ m/s average hydraulic conductivity value, while the Middle Triassic Dolomite by $K_h=10^{-5}$ m/s, $K_v=10^{-3}$ m/s values, but for this formation only one data set was available.

The numerical revision of the archive pumping tests has a great value, because repeating these tests on the present price, would be very expensive, 1500-5000 EUR per well.
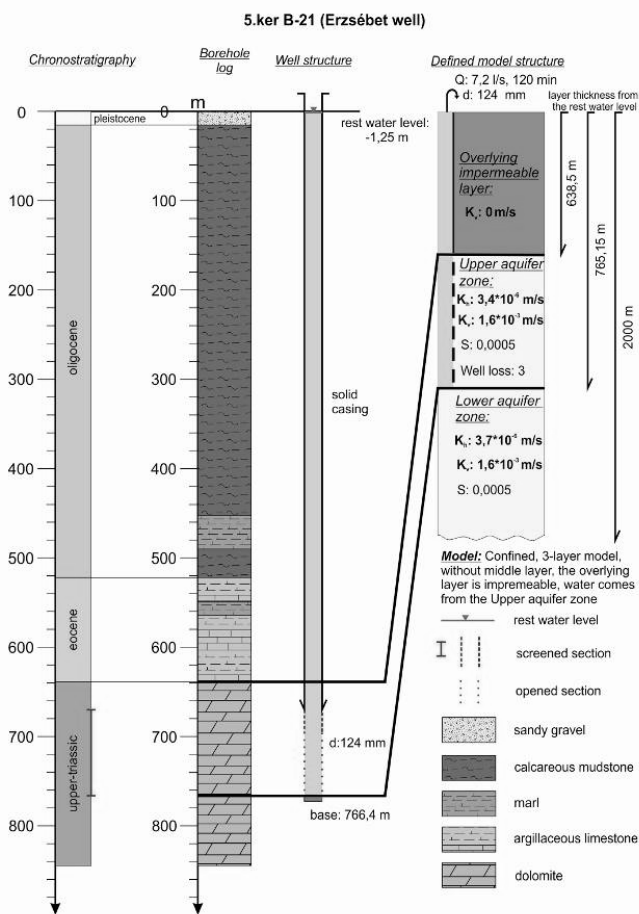

Fig. 1.: An example for the numerical model (B-21 well)

Böcker, T. (1966): A Pascal-malmi termálkút folyamatos kompresszorozása és annak hatása a budapesti termálkutakra, VITUKI Témabeszámoló Kézirat (manuscript, in Hungarian)

Király L. (1975): Rapport sur l'état actuel des connaissances dans le domaine des caractères physiques des roches karstiques. *In*: Burger, A., Dubertet, L. (*eds.*), Hydrogeology of karstic terrains, Int Union of Geol Sci, B, 3:53-67

Székely F., (2006): A háromdimenziós kúthidraulikai modellezési módszer és gyakorlati alkalmazása. VITUKI Közlemények 79.