FROM THE "PALÓC KARST" TO THE FISSURE WATER OF VOLCANIC ROCKS – SELECTIONS FROM HYDROGEOLOGY OF NÓGRÁD COUNTY, HUNGARY

*PÉTER PRAKFALVI**

1. Introduction

Nógrád County is generally considered as an area poor in groundwater and thermal water. This summary statement is only partially acceptable. Significant amounts of cold water and slightly thermal water are available; however, compared to the area of good conditions in the country this county is characterized by lower temperatures of both groundwater and thermal water. This is because there are no large karstic areas on the surface and no subsurface providing intensive water fluxes into the deeper sections. Among pre-Quaternary rocks, the siliciclastic (sandstone) and volcanic rocks play the most important role in watercatchment due to their largest surface coverage; however, the effect of subordinated limestone should not be ignored. This paper presents the geological hydrogeological characteristics of the three hydrogeological units.

2. Limestone

In the area under study two different types of limestone can be distinguished according to their geological ages as well as their karstic development. Triassic limestone occurs only in block spots on the left bank of the Danube – all in all a few km^2 area on the surface, but this still has a relatively significant role in the thermal water regime. There are no karst springs in the county's rock because the karst water level is below the actual erosion base (the karst water level is approx. 110 m bsl), and therefore this water is known only from boreholes. Two of them are introduced in Tables I and II.

Triassic limestone can be found approximately 15 km away from the Bér 1 borehole (in the vicinity of Nézsa), in a relative small area, so it is likely that this thermal water originated from a SW to NE directional upflow which can be identified as a part of the general Transdanubian convective upward flow. However, the possibility cannot be excluded that that the recharge area is the andesite from Cserhát Mountain and the flow is driven from NE to SW. Such a decision requires the analysis of the area in detail.

*Geologist, Hungarian Office for Mining and Geology, 1145 Budapest, Columbus u. 17-23., peter.prakfalvi@mbfh.hu

Table I. Berkenye (core boring in sections)

No.	Z (bsl)	bottom level (m)	Filtered depth interval (m)	Rocks in filtered or opened section
K-1	206.07	482	321.7 – 459.8 (5 sections)	Eocene marl, Triassic limestone, Miocene andesite (not aquifer)
Initial water table (m)	Operating level (m)	Discharge (l/min)	Discharged water temperature (°C)	karstic water level (bsl)
-88.2	-98.0	85	31	118.5

Table II. Bér, borehole (core boring in sections)[1]

No. #	Z (bsl)	bottom level (m)	Filtered depth interval (m)	Rocks in filtered or opened section
Bér 1	202.78	1395.6	1208.6 – 1336.6	Eocene marl, Triassic limestone
Initial water table (m)	Operating level (m)	Discharge (l/min)	Discharged water temperature (°C)	karstic water level (bsl)
-96.6	?	190	52	106.18

Triassic limestone can be found on the surface about 5 km distance SE from the Berkenye borehole, which could be a recharge area, although the andesite of Börzsöny as recharge formation cannot be excluded.

The Miocene types of limestone that are generally deposited on the volcanic formations of Cserhát Mountain are also considered as good aquifers.

From the area of "mini karsts" around Mátraverebély, both downflow-cold (Szentkúti source group) and upstream-warm (Hot Well, 16-17°C) springs originate. Based on investigations of higher discharges (30-60 l/min) the karstic water can be separated quite well from the fissure water of the andesite formations (5-20 l/min).

3. Sandstone

The so-called "Glauconitic Sandstone” formation has the highest surface coverage in the county. Due to its double porosity (pores + cracks) it is considered as a moderate aquifer [2]. Surprisingly, this rock was called “Palóc

Karst" by Noszky [3], a geologist who was familiar with the area, especially because of its denudation. Beyond denudation further study of other features of the karst were also confirmed by their very distant relationships, such as the outgoing sources of edges, but mostly the deposited travertine terraces. During the water cycle as an effect of CO_2 absorbed from the soil and air the 15% carbonated cement material is dissolved from sandstone and deposited as travertine entering into the surface. Discharges of drilled holes in this rock are near to 100 to 200 l/min at some 10 metres drawdown. Thermal waters are not included because of their blocked distribution of tectonics and the cold effect of downstream water.

The downflow is proved by the data of a deep and thoroughly investigated drilled well (Salgótarján, Vv-1=K-3), given in Table III.

Table III. Salgótarján, Vv-1=K-3

depth interval (m)	rocks	Initial water table (m)
117.0-303.9	"Glauconitic Sandstone"	-9.3
317.2-410.6	"Glauconitic Sandstone"	-15.56
410.6-456.9	"Glauconitic Sandstone"	-21.2

Due to the effect of filtration resistance the distinct vertical hydrogeological units are loaded from top to bottom, and not from the bottom of an upward flow [4]. This is partly supported by the extremely high geothermal gradient of the well (15-22 m/°C) compared to the Hungarian average of 30.73 m/°C.

Some borehole data from the area of upward flow (Bátonyterenye-Kisterenye, Ke-1=K-8) are given in Table IV [5].

Table IV. Bátonyterenye-Kisterenye, Ke-1=K-8

depth interval (m)	rocks	Initial water table (m)
93.24-101.6	"bedrock sand of coal II."	+1.7
235.6-239.6	"foot gravel"	+7.6
247.14-256.2	"foot gravel"	+15
258.5-270.7	"foot gravel"	+16.2
287.3-373.0	"Glauconitic Sandstone"	+17.7

The upward flow is confirmed by the initial water table levels increasingly changing with the depths and also by the smaller (anomalous) geothermal gradient (19.63 m/°C). The flow regime is presented in Figure 1, where the water of the downflow system was recovered by a borehole.

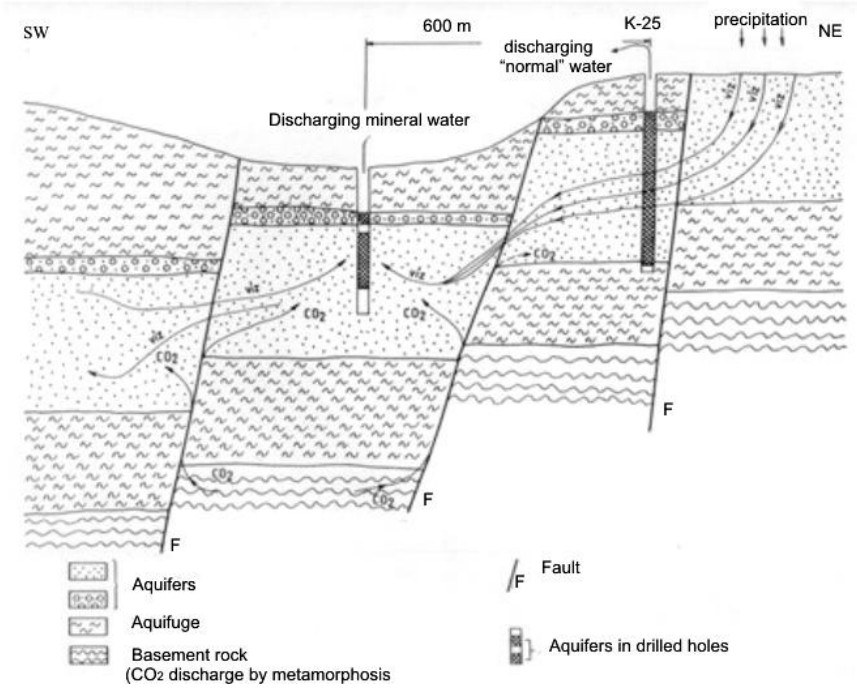

Figure 1. Hydrogeological profile of two boreholes. where the downflow and upflow zones were observed (Edited by P. Prakfalvi P. drawn by J. Kakuk)

4. Volcanic rocks

The volcanic rocks of mountains esentially have a similar role in the water cycle as other karst areas have. as these areas can also recharge. but their conductivity is less than that of the karst [6]. Frequently slightly thermal water can be obtained from the springs. sometimes discharging by reservoir energy at the wells on the shoulders of the volcanic mountains. The amounts of discharging water are considerably smaller than from karstic rocks, which are associated with the material of volcanic rocks. Due to their much higher filtration resistance in cracked or fissured volcanic rocks than in karst,. the ratio of water infiltration is less percentable. Nevertheless, the low temperature requires some explanation. One reason is surely based on the location of volcanic rocks characterized by superficial expansion (a large area for infiltration), in addition to a narrow and thin volcanic root zone (i.e. volcanic vent). The root zone does not provide sufficiently for the penetration of water into the greater depths. According to wells drilled in the root zone of the karst area. the root zone of the karstic areas is greater than their extension on the surface.

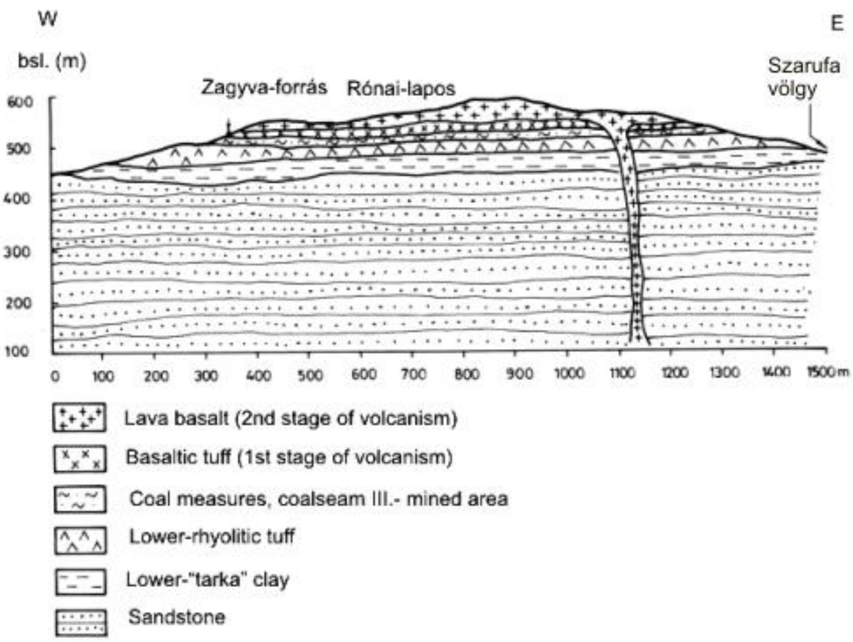

Figure 2. Distribution of basalt rock on the surface is incomparably greater than the area of horizontal section of volcanic breakthroughs (Edited by P. Prakfalvi, .drawn by J. Kakuk)

According to the mining experiences of Nógrád Coal Mine Co., it is known that the volcanic breakthroughs are usually much smaller than the surface distribution of the volcanic area, since the volcanic vents were exploited around by the coal mining procedures. For example, under the almost 13-km^2 Medves basaltic layer just a few breakthroughs – some 100 m^2 vents – have been identified (Figure 2).

The flow regime of an andesite mass (Ecseg, Bézma) and its outbreaks on the surface are shown in Fig. 3. Due to the above-mentioned reasons the gravity drainage of precipitation is restricted by the depth; only lukewarm water flows out both from the thermal spring (20-60 l/min,. 17.6°C) and from the borehole (1-2 l/min).

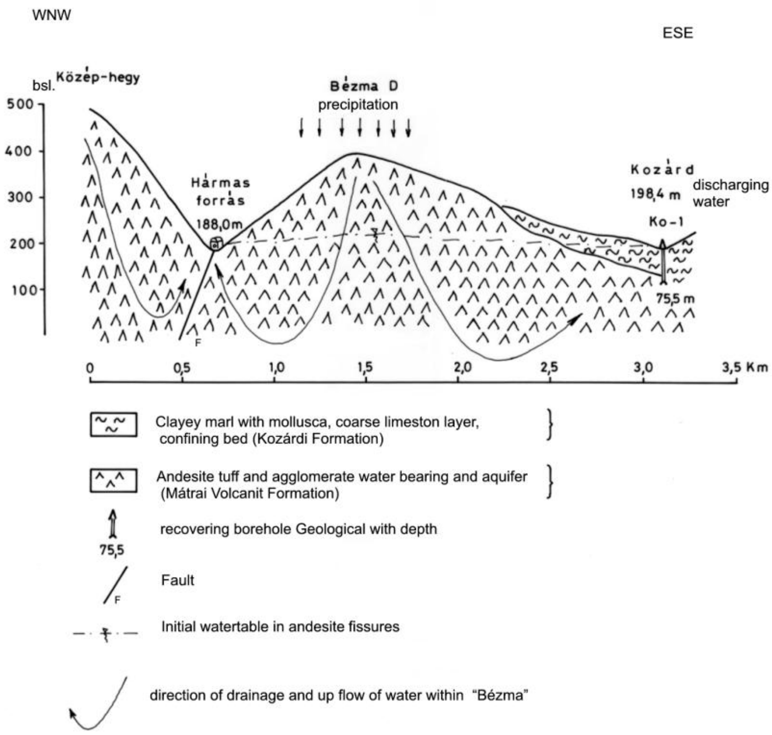

Figure 3. Hydrogeological profile through Bézma hill. (Edited by P. Prakfalvi, .drawn by J. Kakuk)

References

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