ARTESIAN MINERAL WATER OF THE RAOTINCE SITE, TETOVO

Vojo Mircovski[1] , Gose Petrov [1] , Vlado Mircovski[1]

[1]*Faculty of Natural and Technical sciences, Institute of Geology, "Goce Delcev" University, Goce Delcev 89, MK-2000 Stip, Republic of Macedonia*
vojo.mircovski@ugd.edu.mk

A b s t r a c t: A number of mineral springs occur on the west and east peripheral part of the Polog valley. Their appearance is connected with the Western Polog fault that stretches west to the brim of the valley NE-SW direction and east direction of Polog fault stretches in NW-SE. This paper presents the results of detailed hydrogeological investigations of mineral water at the site Raotince Tetovo. Based on data obtained on two operational investigative boreholes at the site in Raotince of the pleistocene limnic sediments at a depth of 38-67 m is founded artesian aquifer with low mineralized water.

Key words: artesian aquifer, mineral water, Raotince, Polog valley, limnic sediments

INTRODUCTION

Raotince site is situated in the western part of Macedonia, 20 km north-east of Tetovo (Fig. 1). The occurrences of mineral and low mineral waters in this area appears in the left and the right banks of the river Vardar from the village Kopance to the village Raotince. In the immediate vicinity of the site Raotince passes the river Vardar. Mineral waters from the wider environment Raotince were investigated by several authors: (Bajic, 1929, Kekic, 1973, 1986, Kotevski, 1980, 1987, Loncar 1996).

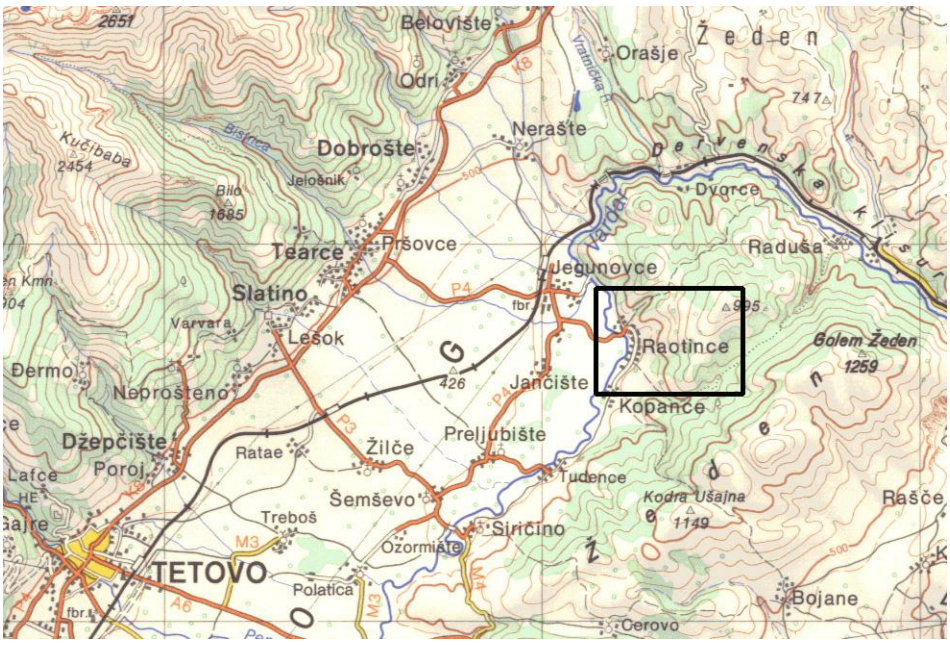

Fig. 1. Geographical possition of the investigated area

GEOLOGICAL COMPOSITION OF THE WIDER REGION

The geology of the region is made up of Paleozoic, Permotriasic, Mezozoic, Tertiary and Quarternary rocks (Petkovski, Karovic, 1977) (Fig. 2).

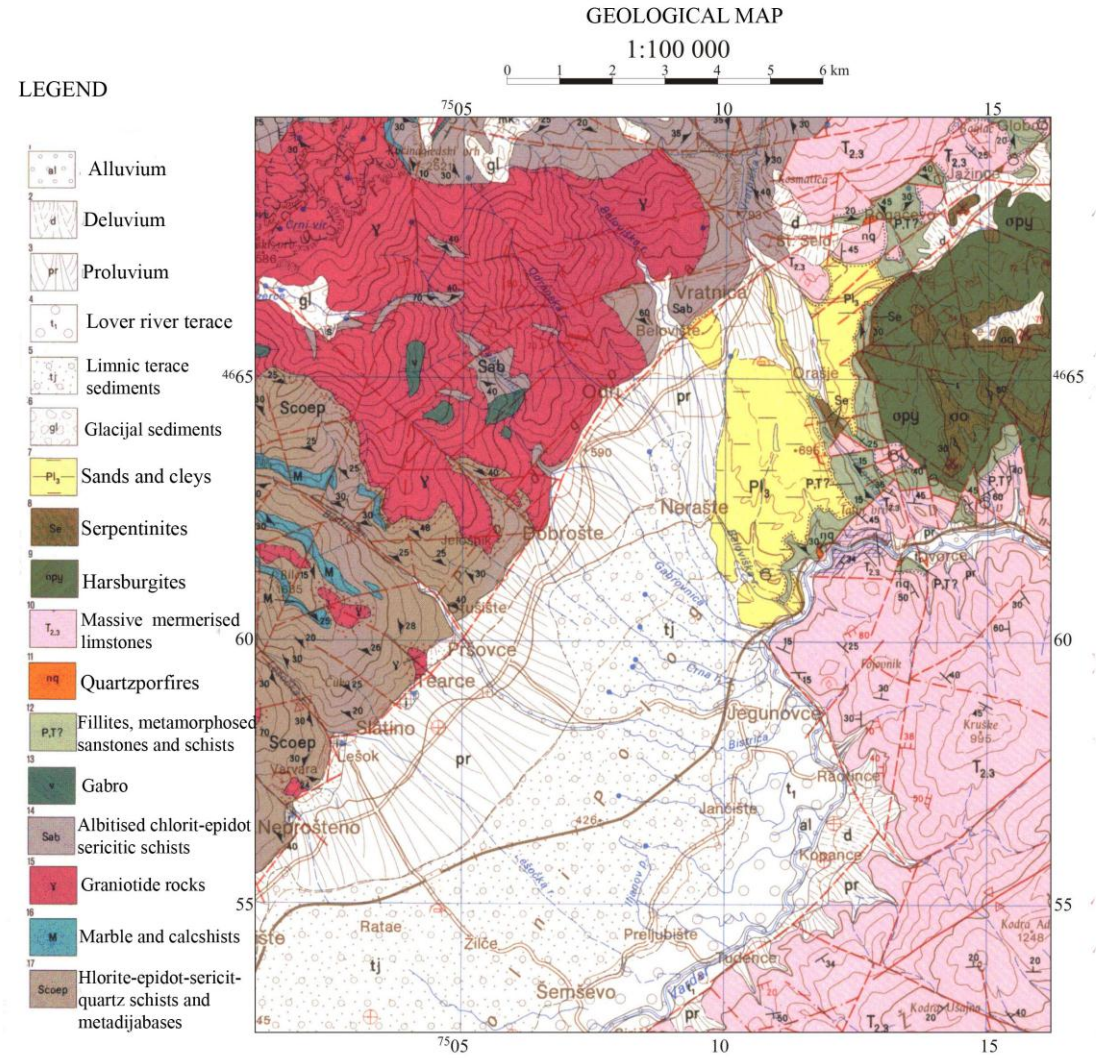

Fig. 2. Geological map of the investigated area. (Petkovski nad Karovic 1977).

The oldest rocks are represented of Paleozoic rocks present of: epidote - chlorite- sericite-quartz schist and metadijabases (Scoep), marbles and kalkshists (M), granite rocks (γ), albitized – chlorite - epidiot - quartz schist, and gabbros (ν). Permotriasic rocks are represented by: filites, metamorphosed cleystones, sandsstones and schists (P, T) and quartz porphyry **(π q).**

Mezozoic is present of Trijasic massive marble (T 2.3), jurasic harcburgites **(σpy)** and serpentinites (Se).

Tertiary is made up of only Pliocene sediments.

Quarterly rocks are represented of: moraine material (gl), limnic terace sediments (tj), lower river terraces (t1), proluvijal (pr), deluvijal (d) and alluvial sediments (al). The investigated area by geotectonic regional aspect belongs to the Western Macedonian zone (Arsovski, 1997).

HYDROGEOLOGICAL INVESTIGATIONS

Two exploration drill holes with a depth of 50 m D1 = D3 = 70 m. were made for the determination of the mineral water at the Raotince site .
With both boreholes artesian water were discovered bearing horizons with low mineral water. Based on data obtained by investigations drilling, was designed hydrogeological profile clearly presented lithological members. (Fig. 3). From the hydrogeological profile it can be seen that the topmost parts of the site-built of alluvial terace sediments which thickness ranges up to 10 meters. In the terace alluvial sediments that are built of gravel and sand aquifer is formed by free level. Under the alluvial terace sediments down to the final depth is determined limnic sediments, presents of gravels, sands and clays and a varieties of their mutual transition. After drilling and purification drill holles have been done galvanized perforated pipes with a diameter 3 " have been filled. By measuring the yield of the drill holles artesian mineral water with capacity of: D1-Q= 8 l/s D3 - Q = 2,6 l/s is obtained.
On the bases of D1 drill hole there is greater yield in it so technical exploration is prepared for exploration as well (Fig. 4). The drill hole is located about 400 meters downstream of the bridge of river Vardar Raotince village.
Based on field observations on known data as a potential zone in which there is mineralisation water zone it is located on both sides of the river Vardar in NW-SE direction. The width of this zone ranges of 250-500 meters in length and can be traced right to the village Kopance.

Fig. 4. Artesian drill hole of Raotince site.

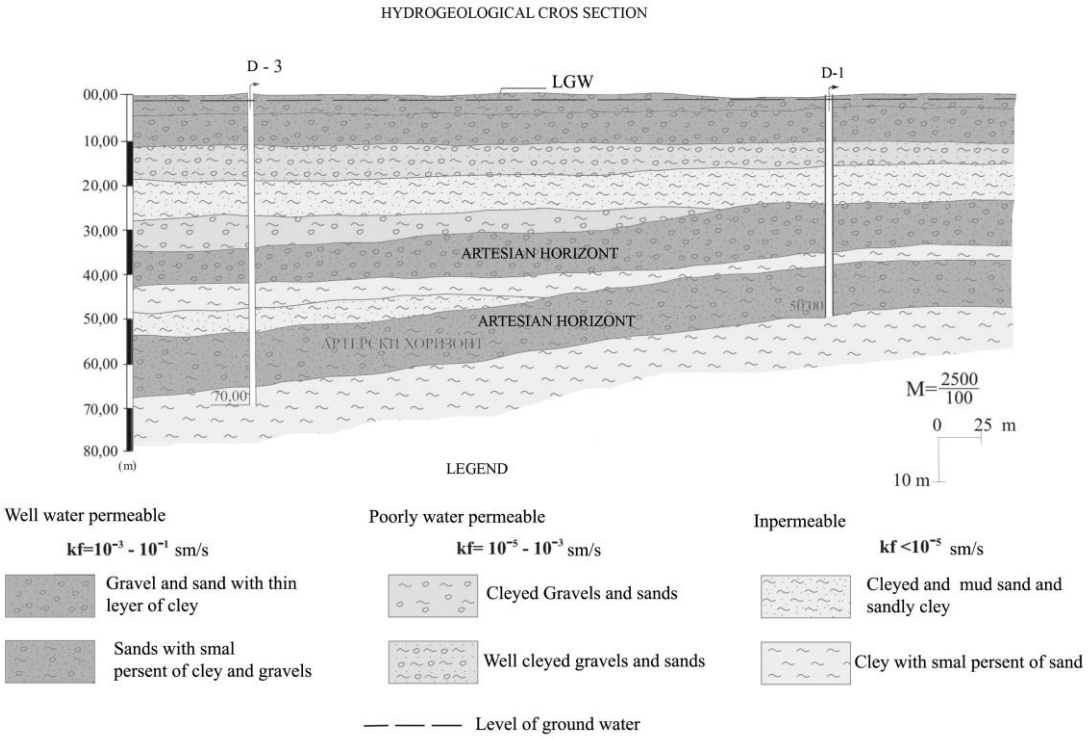

Fig. 3. Hydrogeological profile

CALCULATION OF THE HYDROGEOLOGICAL PARAMETERS

According to the data of the investigation work done a calculation has been made of the hydrogeological parameters of the water bearing environment:

K-coefficient of filtration
T – trasmissivity coefficient
Q – yield of drill hole
N- hydrostatic pressure of aquifere
l- thickness of water-baring leyer

Filtration coefficient

Filtration coefficient is determined based on determination of granulometric composition of samples from the artesian water-baring layer which in the drill holle D1 is in the interval from 38.00 to 49.00 meters and the results obtained by the tests carried out on the well.
The results obtained from the granulometric analyses were used for calculation according to the formula of "USBR".

$$K_f = 0.36 \cdot d_{20}^{2.3}$$

K-coefficient of filtration
d20 - diameter of grains (mm), with representation from 20% to granulometric curve

According to this formula the filtration coefficient was obtained by the following value:
K f = 1.60 x 10^{-1} sm/s, sm/s or 138 m/dey
Static water level is located at + 4.5 m above the surface of the ground. The testing of the well obtained the following values of the capacity of the well Q and lowering the water level S in the well Table 1.

Table 1. Data from the test well

Height of LGW over field H (m)	Capacity Q l/s	Lower level Ho - H) = S
H_1 = 3.20 m	Q1 = 2.40 l/s	S_2 = 1.30 m
H_2 = 1.80 m	Q2 = 5.75 l/s	S_2 = 2.70 m
H_3 = 0.60 m	Q_3 = 8.05 l/s	S_3 = 3.90 m

Based on the obtained parameters for Q and S, calculation of the filtration coefficient has been made according to Krasnopolski (1980), for conditions when artesian aquifer is away from surface waters, there is not monitoring well and when the well radius (r) is very small regarding the radius of its influence (R).

$$K = \frac{0{,}16\,x\,Q}{m\sqrt{r \cdot S}}$$

Input parameters are:
- Q = 8.05 l/s -Well capacity
- S_3=3.90 m - Lowering the water level
- m = 11 m - Thickness of water-bearing layer
- r = 3 "- Radius of well pipe

K = 8.35 x10^{-2} sm / s = 72 m / dey

m = 11 m
T= 72 x 11 = 792 m^2/dey

Transmissivity coefficient

Transmissivity coefficient (T) was calculated according to the formula for the non stationary conditions of streams in the water-bearing artesian layer:

T = K x m

- K - coefficient of filtration
- m - thickness of the water- bearing layer

K = 72 m/dey
m = 11 m
T= 792 m^2/dey

Capacity of the drill hole

After the drill hole has been technically equiped, testing of its capacity has been made.
The measurement was conducted for a period of 13. 5 months and the results are shown in table 2.
A granulated gravel has been placed around the drill hole and over it until the surface of the clay court built as a buffer layer which acts to isolate the mineral waters from the penetration of water from upper layers. The mouth of the drill hole was equipped and protected by concrete manhole and plate.
This equipped drill hole was washed with water and e measuring of the capacity was conducted for a period of 10.22.1995 to 05.04.1996.

Table 2. Capacity of the artesian drill hole

Date of measurement	Capacity Q l/s	Tmperature ^{o}C
22.10.1995	10.22	12.4
12.11.1995	10.06	12.3
05.04.1996	12.0	12.0
11.01.1996	9.70	12.0
10.02.1996	10.28	11.8
15.03.1996	9.55	12.0
14.12.1996	10.00	12.1

After the results of the capacity of the drill hole is concludet to be stable hydrogeological conditions. Based on measurements data the exploitation yield for the drill hole is Qexp. = 10.0 l / s.
However yield over time will decrease because of the dynamic discharge aquifer and reducing the permeability of the filter tubes. Over time this will be monitored and analyzed.

Hydrostatic pressures in the aquifere

Hydrostatic pressures in the aquifere was measured at the outlet pipe, thus obtained values ranging from 1.6 - 2.2 bar.

QUALITY OF THE WATER

Quality ot the mineral water was analized by the National Institute for Health Protection in Skopje have been made two chemical analysis.
According to the chemical composition the water belongs to the group of hydrocarbonate, calcic- magnesian water.
It is characterized by a pleasant tartness, no smell and has increased mineralization ranging from 708-895 mg / l, according to which it belongs to the group of low mineralized water.
According to the pH value (pH = 6.32) water belongs to the group of weakly acidic waters.

CONCLUSION

In the area of Raotince which was covered by detailed hydrogeological investigations in the pleistocene limnic sediments at a depth of 38 - 67 m, was founded aquifer of two artesian horizonts with low mineralized water.
Exploitation drill hole D1 works in stable hydrogeological conditions with capacity of Qexp = 10.0 l/s
According to the chemical composition water belongs to the group of hydrocarbonate, calcic- magnesian water.
According to the mineralization ranging from 708-895 mg / l water belongs to the group of low mineralized waters.

12. ЛИТЕРАТУРА

Арсовски М., 1997: *Тектоника на Македонија.* РГФ- Штип.

Бајиќ Б., 1929: *Минералне и лековите воде у јужној Србии.* Гласник Скопског научног друштва, књ. VI – Скопје.

Котевски Ѓ. 1987: *Хидрогеологија на минералните, термалните и термоминералните води на територијата на Р. Македонија.* Самоуправна практика Скопје.
Котевски Г., 1980: *Извештај за хидрогеолошките истражувања на минералните и термоминералните води на локалитетот Бањиче на реката Пена*. Геолошки завод Скопје. ООЗТ Институт за геотехника и хидрогеологија. Скопје.

Кекиќ А. 1986: *Геологија и хидрологија на Полошката котлина и потеклото на водата од изворот Рашче.* Самоуправна практика Скопје.

Кекиќ А. 1973: *Хидрогеолошке одлике Полошке котлине*. (докторска дисертација).

Лончар И., 1996: *Елаборат за резерви и квалитетот на минералните води на локалитетот Раотинце-Тетовско.* Градежен институт Македонија, Скопје.

Петковски П., Каровиќ, J., 1977: *Толкувач на основната геолошка карта на Р. М. 1: 100 000 на листот Качаник.* Геолошки завод Скопје.

Петковски П., Каровиќ, J., 1977: *Основна геолошка карта на Р.М. 1:100 000 лист Качаник*. Геолошки завод Скопје.

Р е з и м е

АРТЕСКА МИНЕРАЛНА ВОДА ОД ЛОКАЛИТЕТОТ РАОТИНЦЕ, ТЕТОВО

Војо Мирчовски [1] Владо Мирчовски[1]

[1]*Факултет за природни и технички науки, Институт за Геологија, Универзитет "Гоце Делчев" ул. Гоце Делчев 89, МК-2000 Штип, Република Македонија*
vojo.mircovski@ugd.edu.mk

Поголем број на појави и минерални извори се појавуваат по западниот и источниот ободен дел на Полошката котлина. Нивното појавување е поврзано со западно Полошкиот расед кој се протега по западниот обод на колтлината со правец СИ-ЈЗ и со источно Полошкиот расед со правец на протегање СЗ-ЈИ. Во овој труд се прикажани резултатите од деталните хидрогеолошки истражувања за минерална вода на локалитетот Раотинце Тетовско. Врз основа на податоците кои се добиени со две истражно експлоатациони дупнатини на локалитетот Раотинце во плеистоценските езерски седимнати на длабочина од 38 – 67 м е констатиран артески водоносник со слабо минерализирана вода.

Клучни зборови: артески водоносник, минерална вода, Раотинце, Полошка котлина, езерски седименти