HYDROGEOLOGICAL CHARACTERISTICS OF THE ALLUVIAL SEDIMENTS OF THE RIVER BREGALNICA AT THE FORTUNA LOCALITY WATER SUPPLY, STIP

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Abstract: The total water capacity of the Fortuna well system which uses the groundwater for the water supply for the town of Stip amounts to 171 l/s, but today this system yields only 50 l/s. The capacity of individual wells ranges from 10 to 27 l/s with level variations ranging from 2,5 to 5.87 m. Water layer thickness is from 6 to7 m. Mean filtration coefficient after test pumping is 0.4655 sm./s and after the granulometric sampling 0.2 sm./s. Mn content in the water is about 250 times higher than the maximum allowed.

Key words: *Fortuna, alluvial sediments, water sypply, manganese.*

Introduction

One of the localities from where groundwater for water supply of Stip is obtained is Fortuna, situated north and close to the town (fig.1).

The well system for groundwater exploitation is located at the left side of the River Bregalnica where alluvial sediments are widespread. The distance between each well is 50 m, generally about 80 m from the riverside. The alluvial sediment width is about 200 m and prospecting was performed about 800 m in length.

Geological setting

The geological composition of the surrounding of the Fortuna locality according to Rakicevic et. all., (1969) (fig. 1) consists of the geological formations as follows:

- Mesozoic granites,
- Tertiary sediments,
- Quaternary sediments.

The Mesozoic formation is present as Jurassic granites (155±5 m.y. by Rb/Sr method, Soptrajanova, 1967). They are of heterogenous lithological composition

and made up of biotite adamelites, biotitic granites and aplitoid granites crosscut by earlier phase dacite daykes.

The Tertiary is present as a basal series of Upper Eocene conglomerates, marls and sandstones and Upper Eocene flysch sediments made up of sandstones, marls, conglomerates and sandstones. The Pliocene sediments are present as sandstones, loams and gravels.

The Quaternary is present along the River Bregalnica as old river terraces made up of andesitic alluviums, seldom quartz and gneisses as well as alluvial sediments presents as gravels and sands.

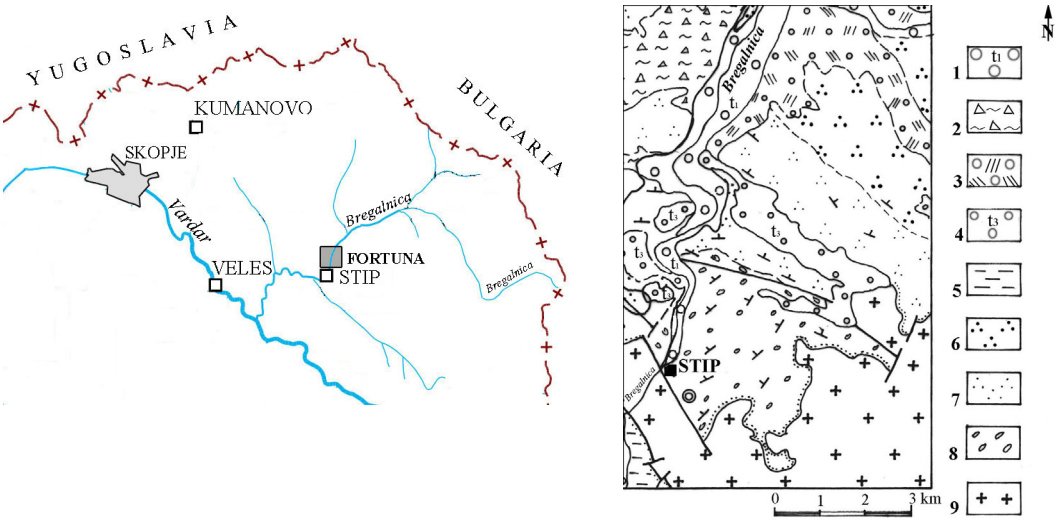

Fig. 1. Geological setting and map of the wider area of the Fortuna locality (T. Rakicevic et. all., 1969)
1. Lower river terrace(alluvial sediments), 2. deluvium, 3. proluvium, 4. old river terrace, 5. Pliocene, 6. upper flysch zone. Eocene: slates, sandstones, 7. Eocene, marls, limestones, slates, 8. basal series: sandstones, marls and conglomerates, 9. Jurassic granites.

Lithological and hydrogeological characteristics of alluvial sediments.

Lithological and hydrogeological characteristics of the area were defined based on exploration drillings of the structure (fig.2) The surface overlying allluvial sediments is covered by 0,2 to 0,3 m thick humus material. Two different lithological parts of the alluvial terrace of the River Bregalnicar can be distinguished: shallow small-size sands occurring maximum 3.5-4,8 m in depth, intercalated by sandy clays of variable thickness and alluvial sediments made up

mainly of river sand gravel and large individual pieces. These sediments comprise the water layer.

The Eocene grey marls of the basal series, which represent impermeable layer, underlie the alluvial terrace. The marl has been established 10-11.5 m in depth.

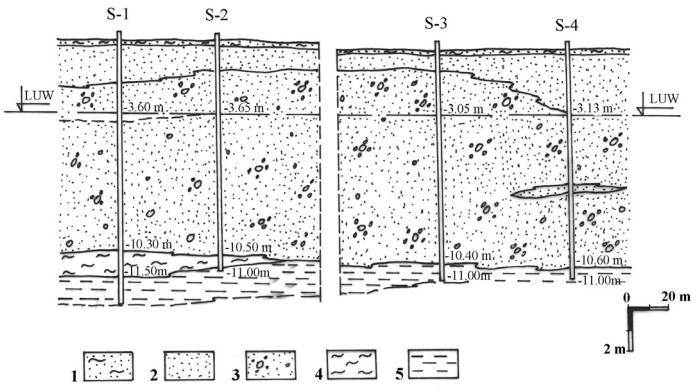

Fig.2. Litological cross- section 1. humus; 2. dust sands; 3. alluvium (water layer) 4. sandy clay. 5. marl (insulator).

The aquifer consists of alluvial sediments of intergranular porosity, which belong to the first terrace of the River Bregalnica. The thickness of the water layer varies between 6 and 7 m and goes 10 - 11 m to depth. The ground water level is shallow and situated some 2 to 5 m in depth and largely depends on the water level of the River Bregalnica. Feeding the aquifer is done mostly by the river waters through the direct hydraulic correlation and, in part, from the atmospheric precipitation.

Granulometric sampling of the materials obtained from the drilling and testing provided basic parameters of the water-bearing medium.

Mean coefficient of filtration according to the granulometric composition of the samples obtained from the drilling is shown in the table 1.

Table. 1. Mean coefficient of filtration according to the granulometric analyses.

S-1	0.099 sm/s	85.2 m/day
S-2	0.13 sm/s	112.8 m/ day
S-3	0.121 sm/s	104.2 m/ day
S-4	0.55 sm/s	47.8 m/ day
S-5	0.10 sm/s	87.5 m/ day
Mean	0.2 sm/s	87 m/ day

Hydrogeological parameters obtained after test pumping were defined based on linear law for non-stationary conditions of filtration table 2. Defining the yield was done for ideal wells of free level of aquifer. Total yield planned for Fortuna well

system for water supply of the town of Stip using groundwater amounts to 171 l/s. Currently only 50 l/s is obtained.

Table. 2. Hydrogeological parameters according to the test pumping.

	DB-1	DB-2	DB-3	DB-4
Q l/s	24	27	25	25
S (m)	3.79	3.18	5.59	5.87
T	T=5.49 x 10^{-2} m^2/s	T=24.70 x 10^{-2} m^2/s	T=1.57x10^{-2} m^2/s	T=1.69x10^{-2} m^2/s
K_f	K = 0.885 sm/s	K = 0.398 sm/s	K = 0.229 sm/s	K = 0.350 sm/s
Mean	0.4655 sm/s			

	B-1	B-2	B-3	B-4	B-8	B-9	B-10	B-5	B-6	B-7
Q l/s	14	11	12	10	13	10	7	5	5	5
S (m)	4	2.5	4.55	5.35	4.45	4.55	max	max	max	max

Hydrochemical characteristics of water

Hydrochemical investigations were performed on processed water from the filter station and unprocessed water from the wells.

All elements studied except for Mn, in the water samples do not exceed maximum concentration allowed for first category drinking water. The maximum Mn concentrations allowed for first category drinking water are 0.005 mg/l, and those in wells are 250 times higher(table 3 (in some samples even higher).

It should be mentioned that most of manganese is eliminated by filtration. However, one analysis indicated significant concentration of manganese which is higher than the allowed for first category drinking water. The increased contents of manganese in unprocessed water fill in the perforated pipes which is one of the reasons for lower yield of only 50 l/s instead of the expected 171 l/s.

Table 3. Mn concentrations in the chemical analyses of the processed water and unprocessed water mg/l.

Analyses	1.	2.	3.	4.	The maximum Mn concentrations allowed for first category drinking water
Mn	**1.246**	**1.112 (4.331)**	0.007	**0.062**	0.005

Analyses 1 and 2 carried out on unprocessed water of the wells by AES-ICP method in the laboratory of the Faculty of Mining and Geology Stip. Analyses 3 and 4 were carried out on filtered water in the Republican Institute of Health of the Republic of Macedonia.

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