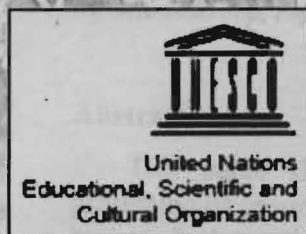


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***1<sup>st</sup> INTERNATIONAL WORKSHOP  
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**ANTHROPOGENIC EFFECTS ON THE  
HUMAN ENVIRONMENT IN THE  
NEOGENE BASINS IN THE SE EUROPE**

**PROCEEDINGS**

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## PROTECTION OF POLLUTION OF THE ARTESIAN AQUIFER AT RAOTINCE SITE-POLOG BASIN, WESTERN MACEDONIA

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### Abstract

This paper shows protective measures should be taken to carry out preventive protection of groundwater from the artesian aquifer in locality Raotince. Based on research by two hydrogeological exploitation investigative boreholes artesian aquifer with poorly mineralized water is noticed in Kvarter - Pleistocene lake sediments with two aquifer layers.

### Introduction

Raotince is located in the western part of Macedonia, 20 km north-east of the city of Tetovo (Fig. 1) the emergence of mineral waters and mineral waters poor in this area appear in the left and the right bank of the river Vardar from village Kopance Raotince to the village. In the immediate vicinity of the site Raotince passes the river Vardar. Mineral waters from the wider environment Raotince be examined by several authors: (Bajic, 1929, Kekic, 1971-1972, Kotevski, 1973-1976).

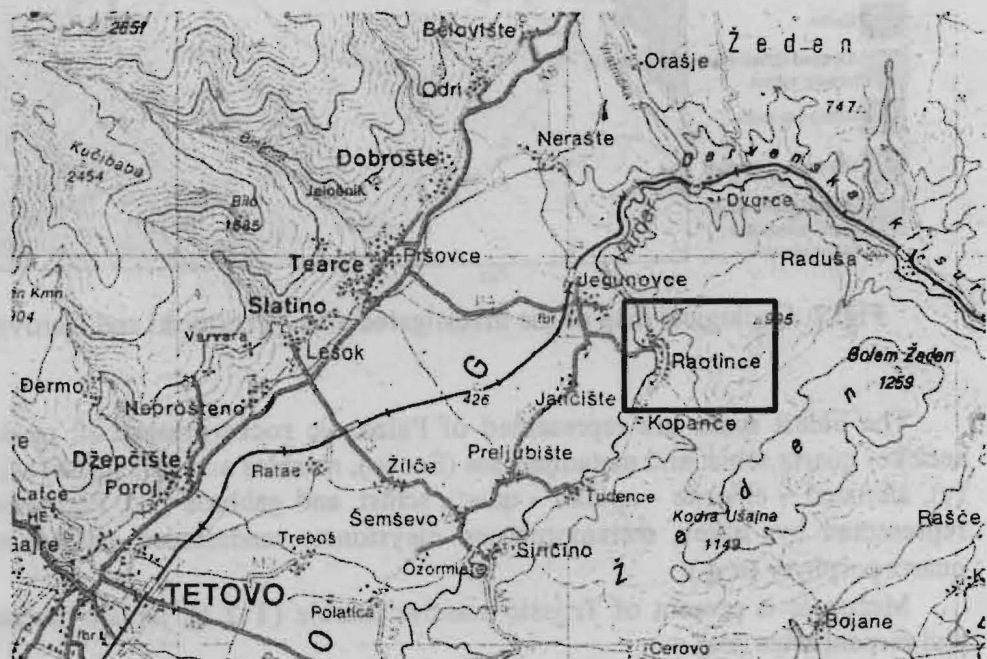


Fig. 1. Geographical position of the investigated area.

### Geological composition of the wider region

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

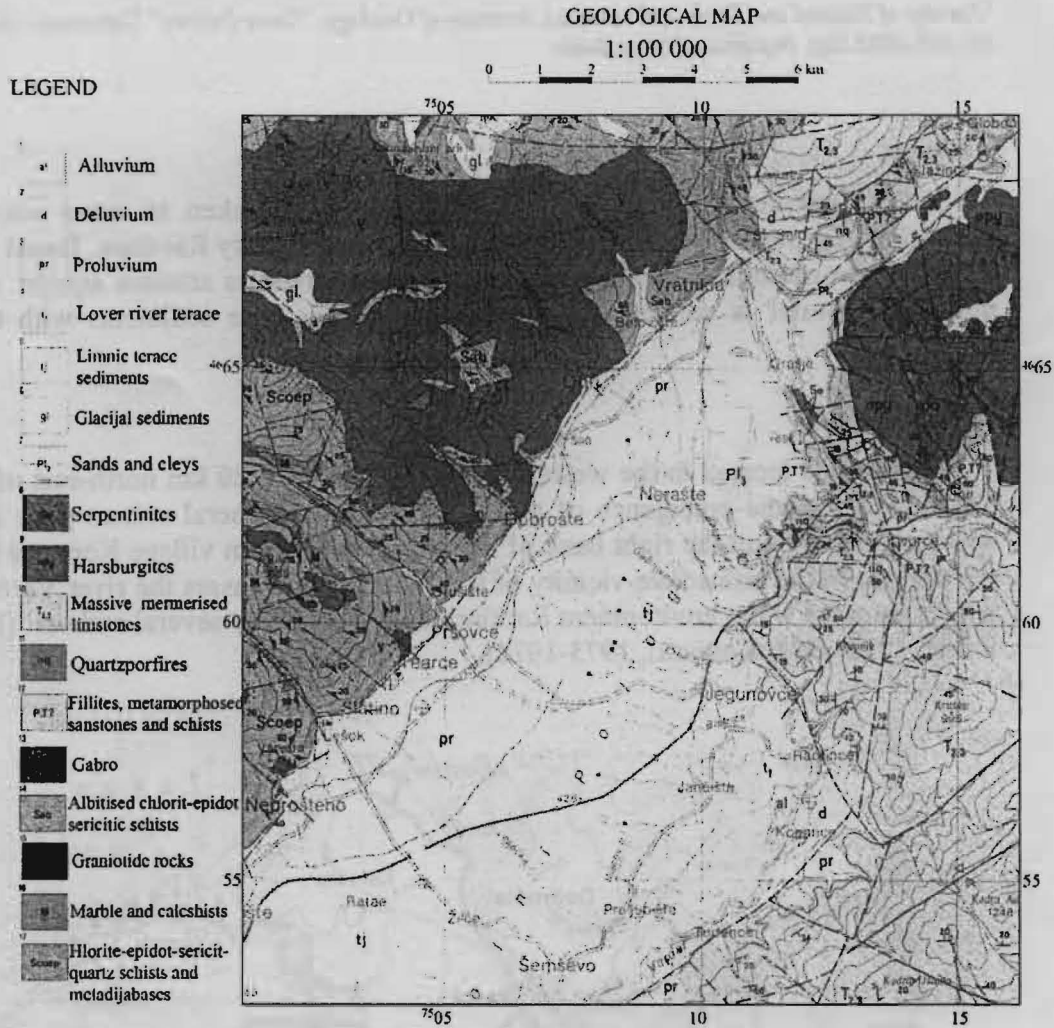


Fig. 2. Geological map of the investigated area. (Petkovski and Karovic 1977).

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 (v). Permotriassic rocks are represented by: fillites, 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 terrace 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 features of artesian aquifer

Hydrogeological features of the artesian aquifer from Roatince locality is according to data obtained from two investigative exploitation boreholes that are performed to a depth of D1 = 50 m and D3 = 70 m.

Based on data obtained by investigative drilling hydrogeological profile is designed of which is represented litological members and their mutual relationship (Fig. 3). From the hydrogeological profile can be seen that the topmost parts of the terrain is built from quarter alluvial - terraces sediments whose thickness ranges up to 11 meters. These alluvial terraces sediments which are built of gravel and sand have formed aquifer with free level. Under the alluvial-terraces sediments until the final depth of drillholes is determined Quarter - Pleistocene lake sediments, presented with gravel, sand and clay as well as their mutual shifts.

Artesian aquifer was founded by two aquifers layers with various granular gravels and sands with a small percentage of clay. Artesian aquifer layers in D-1 well is found at a depth of 24-35 m and 38-49 m, and in D-3 well on the depth of 35-43 m and 55-67 m. Above and below the aquifers there are clay sediments which are sandy in individual places.

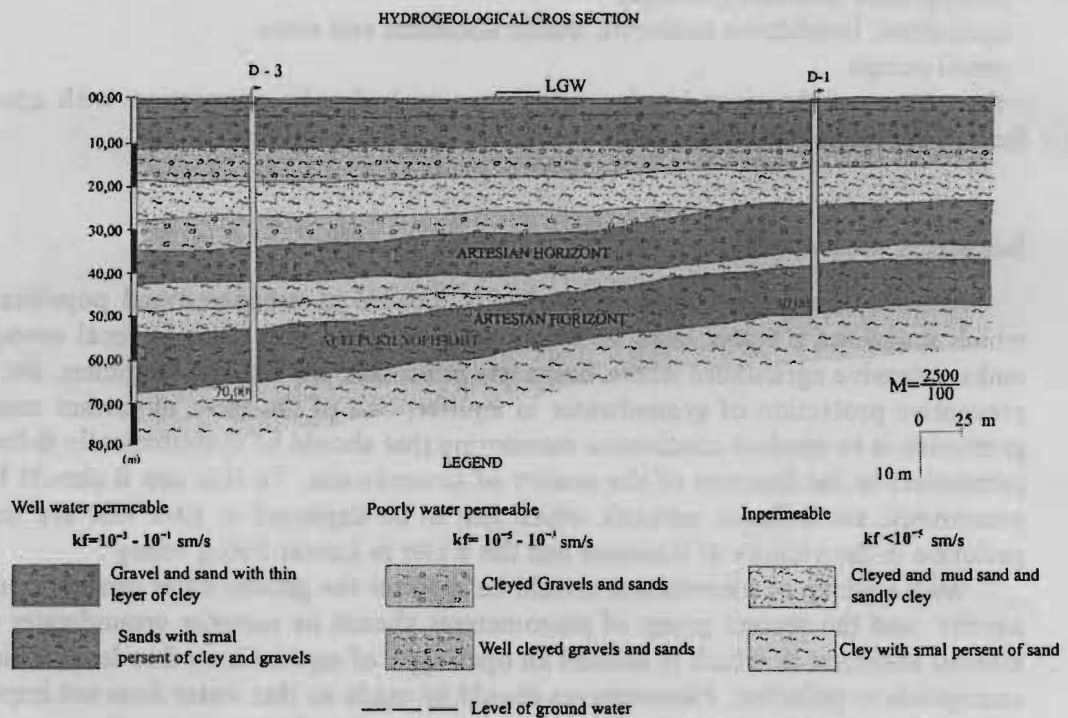


Fig. 3. Hydrogeological profile.

## Quality of the water

Quality of the mineral water was analyzed 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.

### **Opportunities for pollution of artesian water**

In order to protect groundwater from artesian aquifer will be discussed some opportunities where it can be contamination occur .

Like most prospective areas in which can lead to contamination of groundwater in artesian aquifer can be:

- Active water intake facilities (wells)
- Excluded and abandoned wells and piezometers
- Zones of feeding - underground flow of aquifer
- Roof sediments with vertical infiltration of pollutants

Critical areas for contamination of groundwater from the aquifer with free level which is formed in alluvial sediments can be:

- shallow, dug wells, septic tanks, farms
- underground facilities (sewage)
- agriculture, breakdown outbursts, traffic accidents and more.
- petrol pumps
- the waters of the river Vardar, which are in hydraulic connection with aquifers that formed in alluvial sediments

### **Suggested measures for protection of artesian waters**

Artesian aquifer in Raotince locality is located in urbanized and populated area in which space has a higher number of potential contaminants such as fecal sewage, septic tanks, intensive agriculture where farms use pesticides, herbicides, fungicides, etc. To make preventive protection of groundwater in aquifer, one of the most important measures for protection is to conduct continuous monitoring that should be systematically follow certain parameters in the function of the quality of groundwater. To this aim it should be formed piezometric surveillance network which has to be deployed at sites that are sensitive to pollution in the vicinity of Raotince and the wider in Lower Polog valley .

With a group of piezometers should be monitor the groundwater quality from artesian aquifer and the second group of piezometers should be monitor groundwater quality in alluvial sediment in which is formed an open type of aquifer by a free level which is very susceptible to pollution. Piezometers should be made so that water does not impoundment both of aquifer in order to be follow environmental pollution especially in every aquifer areas. The location of piezometers should be choose according to local conditions on the terrain, in order to get first the information about the possible contamination of groundwater. Based on this information would be take appropriate measures would not be led to pollution of water from deep artesian horizons.

Since there are no available of sufficient data from which can accurately determine the feeding zones of artesian aquifer which are most sensitive areas through which may come from water pollution on aquifer, it is necessary to make detailed hydrogeological

investigations combined with tracer tests. These studies should define the direction of movement of groundwater and to define zones of feeding artesian aquifer.

Some extraction wells which will draw the water from artesian aquifer and from the aquifer with free level should be defined sanitary protection zones that should be given proposed measures to make preventive protection of groundwater.

## Conclusion

To make preventive protection of artesian waters from in artesian aquifer from Raotince locality, should be carried out continuous monitoring piezometric network to be deployed at sites that are sensitive to pollution in the vicinity of Raotince and the wider Lower Polog valley.

Around extraction wells which will draw water from artesian aquifer and from the artesian with free level should be defined sanitary protection zones that should be given a proposal for preventive measures protecting groundwater.

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