

3.2. HĂGHIMAȘ KARSTIC MASSIF

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Hăghimaș (or Hășmaș) Mountains lay in the area of Eastern Carpathians of Romania, like a preponderant carbonate zone, far away from crowded living and industrial areas, therefore far away from hazardous polluting environment. The reference points of the whole area are Lacul Roșu Resort and Bicz Valley, the latter with its gorges being like a “backbone” for the region.

General Considerations

In the whole Hăghimaș massif area, important from karstic hydrogeological point of view are central and southern parts and from northern zone only areas where carbonate formations occur.

The main ridge of Hăghimaș Mountains includes exceeding 1400 m, and the summit is Hăghimașul Mare (1790 m). In the eastern part of the massif a lower ridge occurs (Damucului Ridge), situated between longitudinal valleys of Damuc and Bicăjel.

The relief appearance of the area is considerable affected by geological aspects. Thus, in the areas where limestone and dolomite occurs, the relief is abrupt, with high walls having debris or scree to the base, sometimes very good developed (The Mills of Piatra Ascuțită). But in the areas where the wildflysch formation is well developed the relief is mild with rounded ridges and frequent landslides.

The Bicz Valley penetrates the considerable area from SV to NE and it is one of the most important transversal valleys that run through the internal part of Eastern Carpathians. The Bicz Valley springs from Lacul Roșu Lake (upstream this lake the valley is called Piatra Roșie Brook). Lacul Roșu Lake had occurred in 1838 when the valley was obstructed by a huge landslide, creating in this way a natural accumulation lake.

The main affluents of Bicz Valley, for this sector are: Lapoș, Șugău and Bardos Brooks from

the left side and Dămuc and Bicăjel on the right side (the latter, with its 18-20 Km being the longest). The Calului Brook discharge itself in Piatra Roșie Brook that directly refill the Lacul Roșu Lake.

From climatical point of view the Hăghimaș Mountains situate themselves in the high mountains climatical regions with large annual variations of temperature and precipitation. The average temperature of the air has values between +2 and +4°C. The precipitation has annual values between 800 and 1000 mm. In a large majority (over 70%) the precipitation comes down in warm season (April-September), but mainly in July and August.

Geological Considerations

Stratigraphy

Geological formations developed in the considerable area belong to two different tectonic units with overthrust rank: Bukovinic Overthrust and Transylvanian Overthrust of Hăghimaș (Fig.1).

Bucovinic Overthrust

Rarău Gneiss Series comprehends, on both flanks of Hăghimaș syncline, moderate grade metamorphic formations (micaschist with biotite and muscovite, paragneiss with biotite, quartzfeldspar gneiss with muscovite).

Tulgheș Series. The low grade metamorphic formations belonging to Tulgheș Series (phyllite, metatuff, black quartzite) occur in the eastern part of the area, in Damucului Ridge.

Triassic. The development of Triassic deposits is irregular on the both flanks of Hăghimaș syncline. On western flank and especially in the Lacul Roșu area the Triassic deposits have considerable thickness and are completely developed (the notable thickness has detrital Seissian and also carbonate Campilian-Anisian, represented by dolomite and dolomitic limestone). From the contrary, on the eastern flank only Anisian dolomite occurs.

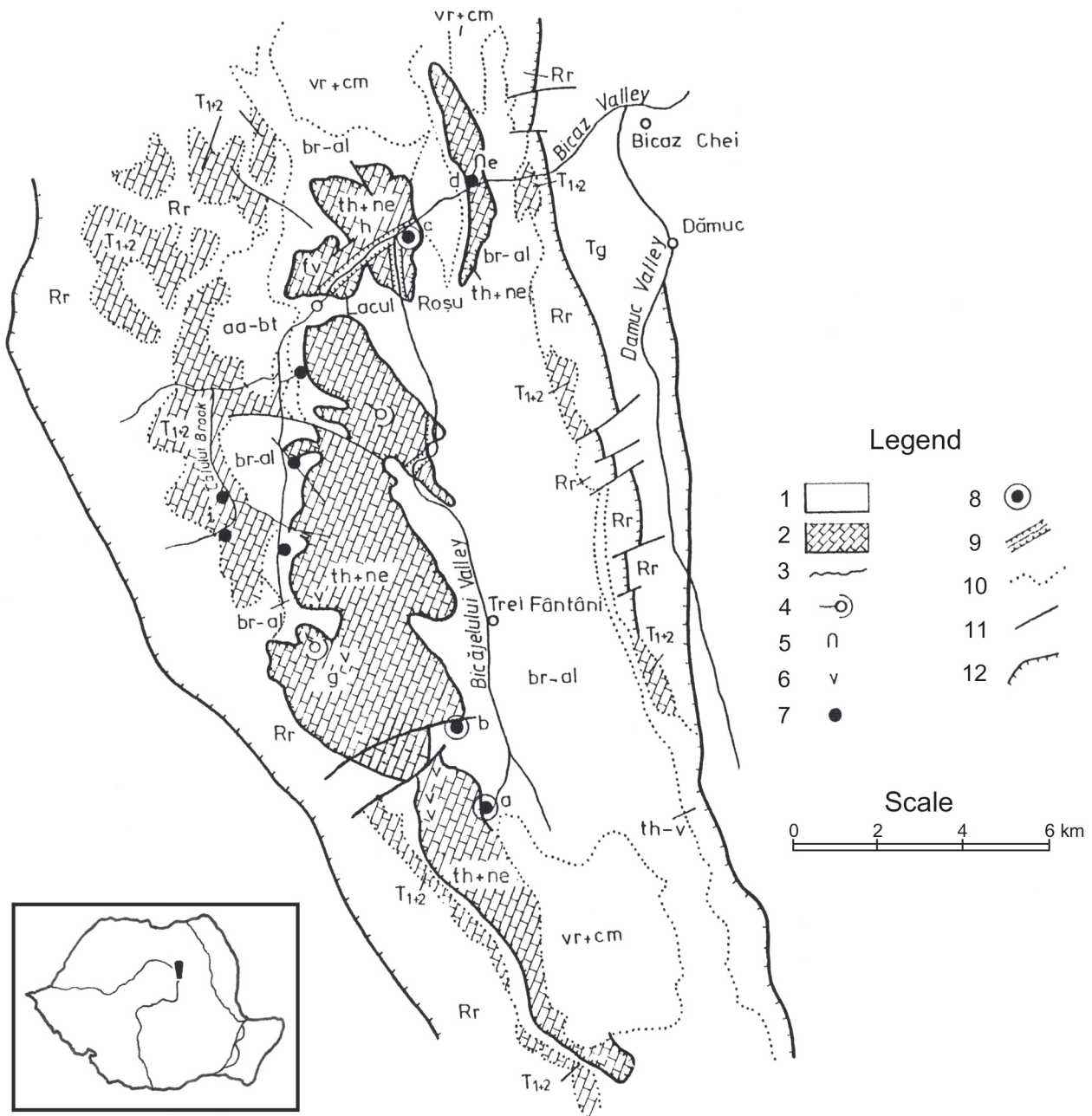


Figure 1. Hydrogeological map of Hăghimaș Mountains (Geology after Săndulescu M., 1975).

1. Non-karstifiable deposits:

- Rr – Rarău Series;
- Tg – Tulgheș Series;
- aa-bt – sandy limestone;
- th-v – marly limestone;
- br-al – wildflysch formation;
- vr+cm – conglomerates;

2. Carbonate deposits:

- T 1+2 – dolomite;
- th+ne – white and red limestone;

3. Watercourse;

4. Swallet;

5. Cave;

6. Pothole;

7. Karstic spring Q = 1-5 l/s;

8. Karstic spring Q = 30-250 l/s;

9. Gorges;

10. Geological boundary;

11. Fault;

12. Overthrust;

a. Trei Fântâni Spring;

b. Cald Spring;

c. Surduc Spring;

d. Șugău Spring;

e. Munticelul Cave;

f. Peter Baci Pothole;

g. Poiana Albă;

h. Bicaz Gorges;

i. Calului Brook Springs.

Aalenian-Bathonian appears in Lacul Roșu area and is represented by sandy limestone.

Tithonic-Valanginian (The Lunca Strata) develops like a narrow band on the eastern flank of Hăghimaș syncline and from lithological point of view is constituted by marly limestone and sandy limestone.

Barremian-Albian. The Lower Cretaceous deposits are represented by wildflysch formation (siltstone, claystone, marl, etc). This formation is one of the most characteristic formations for Bucovinic Overthrust, occupying large surfaces in Hăghimaș syncline area.

Transylvanian Overthrust (Hăghimaș Overthrust)

Tithonic-Neocomian. The main body of Hăghimaș Overthrust is constituted by a massif carbonate pile exceeding 600 m of thickness represented by massif oolitic limestone, massif coral red and white limestone occasionally with calcarenite aspect and fine micrite limestone.

The Post Tectonics Overlay

Vraconian-Cenomanian deposits are represented by Bârnadu conglomerates and constitute a formation that transgressive overlay both Hăghimaș Overthrust and Bucovinic Overthrust.

Tectonics

The Mesozoic formations from Hăghimaș Mountains constitute a great syncline with the axis orientated N-S, in which other axial and transversal folds still appear. Like a general idea, the deposits are strongly stirred and cut by great number of faults and joints, that together with bedding plans are ways of circulation for water in the mass of rocks.

Hydrogeological Considerations

In Hăghimaș Mountains the main body of karstifiable rocks belongs to the Tithonic-Neocomian and includes massif white and red limestone. The karstifiable deposits lay over an impervious wildflysch substratum of Barremian-Albian age.

The whole body of karstifiable formations is separated into several blocks, bordered by impervious formations or by longitudinal and transversal faults. Each of these blocks is drained by karstic springs, located either at the contact between karstifiable and non-karstifiable formations or in the fault areas that cut the limestone.

The recharge of the aquifers located within the carbonate rocks is mainly provided by diffuse seepage of rainfall on the limestone and dolomite outcrops, but sometimes temporary swallets may appear.

In such settings occur the most important springs of considerable area, that will be described below (Fig. 1).

Trei Fântâni Spring

This spring appears on the left bank of Bicăjelului Valley, at 4 km south from the homonym village, at 1080 m absolute altitude.

The water springs from coral limestone of Tithonic-Neocomian age belonging to Hăghimaș Overthrust at its contact with impervious wildflysch formation. The discharge varies between 12 and 31 l/s, with the temperatures between 4.7 and 7°C.

The average TDS values for 4 samples collected every second month is 348 mg/l.

Considering the time evolution for the main ions content and main chemical parameters for samples collected once and stored in the laboratory to be analyzed every second month (Fig. 2) it may be noticed that after 6 month from sampling a decrease of all values with more than 50% had occurred.

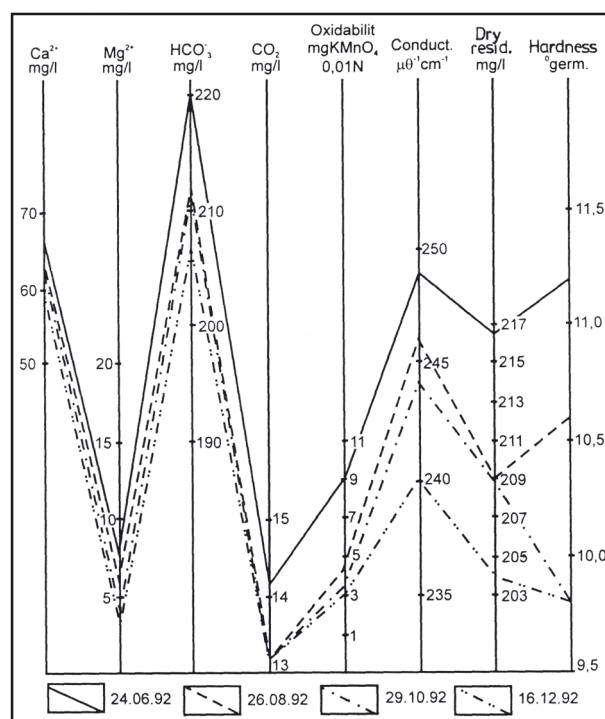


Figure 2. Trei Fântâni Spring. The time evolution for the main ions content and main chemical parameters for spring water collected at 16.06.1992 and stored.

Cald Spring

Cald Spring is located in Bicăjelului Valley hydrographic basin, in its left bank, at 1014 m altitude. The water appears at the base of 20 m high wall. In 1983 it had been an unsuccessful attempt to blow up the limestone wall, hoping to open an entrance in an eventual karstic system. The pyrotechnical experience, although it was a failure, had let dramatic marks in the spring area, the whole vicinity having a chaotic aspect.

The spring occurs at the contact between Thitonic-Neocomian limestone belonging to Hăghimaş Overthrust and marly sandstone of Barremian-Albian wildflysch (Fig. 3). The limestone has a vertical cleavage (N62V/85NE) and fractures mainly following N20V/60NE and N70E/75SE directions.

The discharge of this spring fluctuates between 175 l/s in September and 245 l/s in June. The temperatures of the water are between 4 and 6.5°C.

Surduc Spring

This maybe one of the most notorious springs in the area, being located in the Bicaz Valley Gorges, in the sector called Gâtul Iadului, in the right side of the river, having only 1 m above river bed (relative altitude), and 800 m absolute altitude. There are a few synonyms for Surduc Spring like: Rece Spring, Mariei Spring, Regelui Spring, etc.

The water springs through 3 large tension gashes or fractures with positions oscillating around N10E/60NE value.

The discharge of this spring fluctuates around average value of 130 l/s with an average temperature of 6°C.

Şugău Spring

The Şugău Brook is a left side affluent of Bicaz Valley, and in the confluence area is cutting the limestone from the front of Hăghimaş Overthrust, generating the homonym gorges (Şugău). Immediately upstream these gorges, in the left bank of the river, the Şugău Spring occurs, at 695 m altitude.

The average discharge of this spring is 3.4 l/s, temperature varying between 8.5 and 9.5°C, with TDS value of 397 mg/l.

Calului Brook Springs

In the Calului Brook area there are two water sources that spring from Campilian-Anisian dolomite (Fig. 4). The discharge of both neighboring springs is 3-4 l/s, with TDS values between 286 and 377 mg/l.

The absolute altitude of these springs is 1050 and 1105 m, respectively.

The recharge of these two springs is provided mainly by diffuse seepage on the dolomite areas.

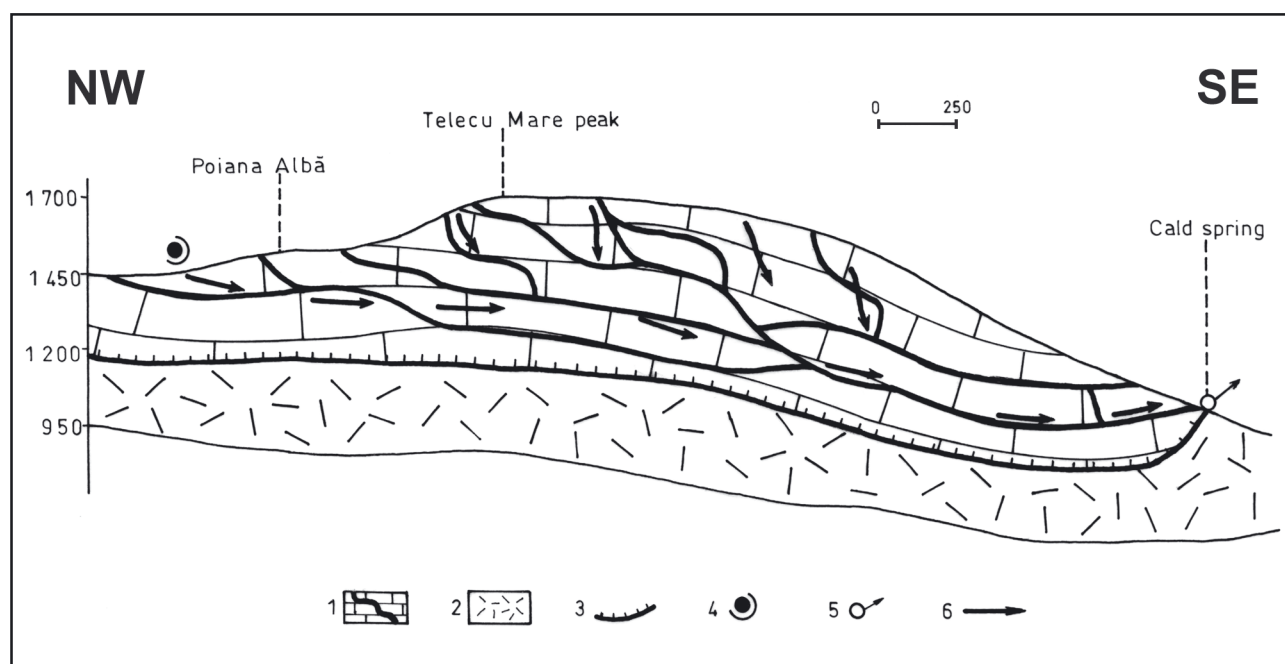


Figure 3. Hydrogeological cross section in Cald Spring area.

1. Tithonic-Neocomian fractured and karstified coral limestone; 2. Barremian-Albian wildflysch impervious formation; 3. Overthrust; 4. Temporary swallet; 5. Karstic spring; 6. Flow directions.

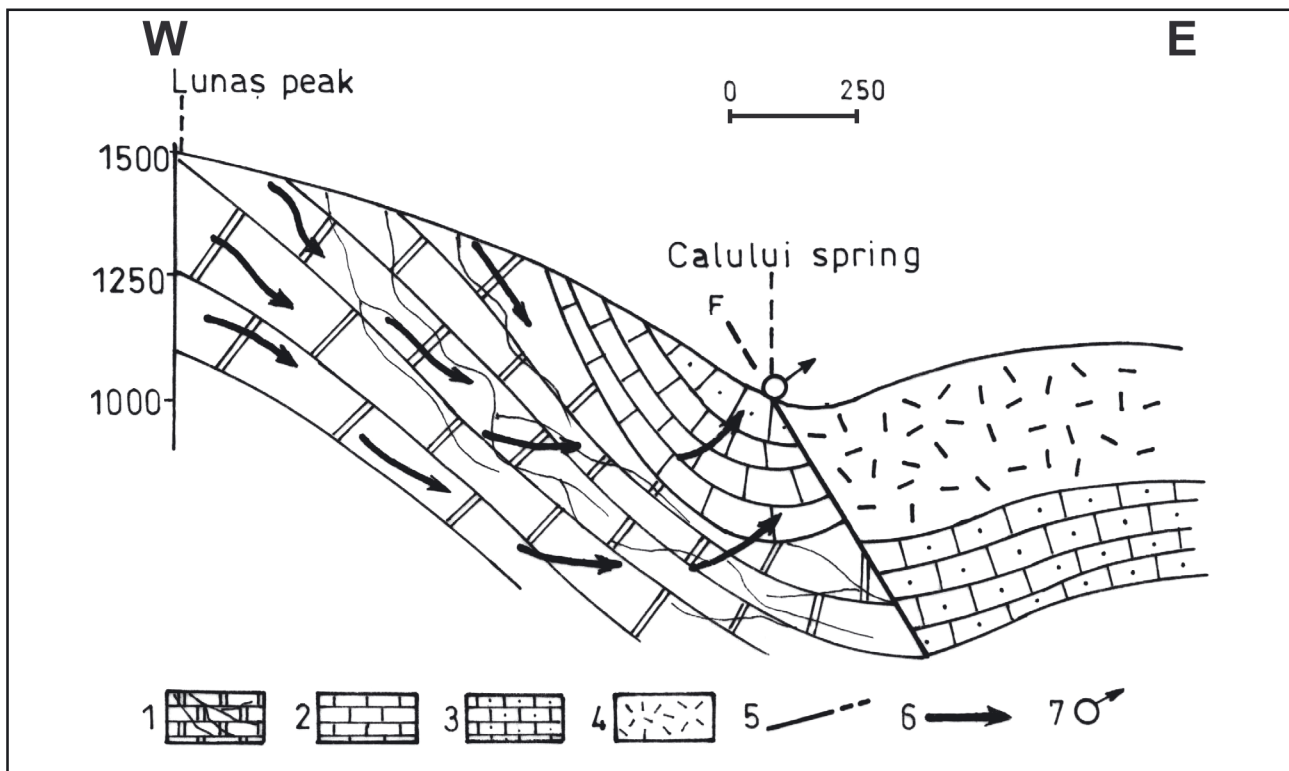


Figure 4. Hydrogeological cross section in Calului Brook area.

1. Campilian-Anisian fractured, aquiferous dolomite; 2. T 2 white limestone; 3. Aalenian-Bathonian sandy limestone; 4. Barremian-Albian wildflysch impervious formation; 5. Fault; 6. Flow directions; 7. Karstic spring.

The Karstic Phenomena

The exo-karst is really well developed in the area of Hăghimaș Mountains, the most representative forms are gorges. The Bicaz Valley Gorges are impressive, deep, with high walls and are one of the most important gorges in Romania. Also other rivers of the area have notable gorges: Bicăjel, Lapoș, Bardos, Șugău.

Sometimes the large dolines (sinkholes), with temporary swallets occur, like in Poiana Albă area (Fig. 3). Ridges, towers (like Piatra Altarului and Piatra Singuratică), pillars, needles also frequently appear. The vertical walls are well represented in all gorges.

The endo-karst is rather insufficiently represented. The most important cave in the area is Munticelul or Ghiocelul Cave situated in Șugău zone, having only 120 m of galleries, being developed at the intersection of two large fractures. Notable is also the Peter Baci Pothole, but this is a tectonic phenomenon.

In the main ridge of Hăghimaș Mountains a prospecting with light mining works (galleries, pits) was developed in the years 1980s, to delimitate

the contour and quality of limestone, forecasted to be used in cement industry. Today, these works and their dumps are still visible, but fortunately for the integrity of the massif the limestone is extracted in a large quarry, located downstream Bicaz Valley in the vicinity of Bicaz Chei Village.

General Hydrochemical Considerations

In the considered area, it may be noticed a correlation between quantities in reaction for main anions and cations for each spring and petrographical type of rock (limestone or dolomite) where the aquifers that discharge through these springs is located (Table 1).

The waters emanated from carbonate deposits of Hăghimaș Mountains belong to calcium bicarbonate type with very low concentration, thus the TDS has values between 286 and 397 mg/l. The dry residues (obtained after 105°C drying process) varies between 205 and 286 mg/l. The pH values are constant in time and space, slightly oscillating around 6.2 value.

Name of the spring	Reservoir rock	Ca ²⁺	Mg ²⁺	Na ⁺	Cl ⁻	SO ₄ ²⁻	HCO ₃ ⁻
Trei Fântâni	limestone	40.0	8.0	1.3	6.9	0.3	42.8
Cald	limestone	42.6	6.5	0.6	6.8	0.25	44.4
Surduc	limestone	46.7	1.4	1.5	3.5	0.8	45.6
Șugău	limestone	43.5	4.5	1.75	4.6	0.4	44.9
Calului A	dolomite	27.1	20.5	1.9	3.8	1.25	44.9
Calului B	dolomite	24.0	24.1	1.2	8.1	1.0	40.8
Ionic Formula is: HCO ₃ Cl SO ₄ Ca Mg Na							

Table 1. Quantities in reaction, in percentage of milliequivalent per liter (meq/l), for underground waters in Hăghimaș Mountains.

The total hardness (measured in German degrees) is low, between 9.6 and 12.7, although the waters are coming from limestone and dolomite, having much lower values than expected.

Concluding this exposure it may be underlined that the waters of the springs described in this paper, with an accumulated flow of 0.3 m³/s fulfill all the chemical, bacteriological, radioactivity and pesticide content requirements of drinking water standards in order to be classified as still waters (flat uncarbonated waters).

References

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