3.4. BUCEGI MASSIF

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Introduction

The Bucegi Massif lies in the eastern extremity of the Meridional Carpathians. Some springs which are rising from the mountain slopes have been collected for public water supply of the towns Buşteni, Sinaia and Târgovişte. The biggest spring ("Şapte Izvoare Reci", 400 l/s) is tapped for water supply for Târgovişte town, and for bottlening. Another spring (from Buşteni aria) is now the object of an exploration program to promote this one in a natural mineral water category. Others 16 sources are tapped, providing about 500 l/s for water supply.

This paper considers the most important aquifers of Bucegi Massif, their vulnerability to pollution and their potential to be used for public supply or like natural mineral water sources.

Geological data

The geological data after Patrulius, (1967) has been simplified.

The basement of Bucegi Massif includes the contact zone of two major units: the Getic Unit to the West and Sinaia Beds Unit to the East.

At the western part of the massif, the Jurasic carbonate formations lie directly over the crystalline schists of the Leaota Mountains.

The crystalline shists plunge toward the centre of the massif and support Cretaceous sediments of Aptian - Albian age.

The eastern part of the basement includes flysch deposits (Sinaia Beds) of Neocomian age. The Neocomian flysch represents the lower part of the whole flysch formation. The latter is prevalently constituted by marly and clayey sequences. The upper part of the flysch (Barremian - Aptian) displays a variable facies, with prevalently marly character. As a consequence, the sedimentary material has a little interest as reservoir rock, although it often includes conglomerates (Bucegi Lower Conglomerates) and blocks of Jurassic reef limestone. The flysch deposits outcrop along a North-South strip bordering the steep eastern mountainside.

Above the flysch deposits, an enormous sedimentary mass of Albian age lies in the central zone of the massif. The bottom of the sediments consists of Bucegi Medial Conglomerates. The upper part includes three distinct formations: Bucegi Upper Conglomerates (with various facies), Babele Sandstone and Scropoasa - Laptici Sandstone (marly sandstone).

Upper Cretaceous sediments including sandstones, conglomerates and marly deposits outcrop sporadically in the South and in the North of the Bucegi Massif.

Quaternary sediments include argillaeous sands and gravels (Lower Pleistocene age), in Sohodol zone. Along the valleys, glacial, alluvial-glacial and delluvial deposits (Upper Pleistocene and Holocene age) also occur.

Hydrogeological data

The previous hydrogeological studies have been made for water supply (Nedelcu et al., 1992) and about the recharge zone of "Şapte Izvoare Reci" source (Pârvănescu, 1991).

The main aquifers of Bucegi Massif generally occur within limestone, conglomerate and sandstone formations (Fig.1). The limestone outcrops on 18 km^2 area, reaching a maximum thickness of 400 m. They include aquifers with a pronounced karstic character.

A similar karstic character has been also ascribed to the aquifers hosted by conglomerates: Bucegi Medial Conglomerates, from which Obârşia - Coştila type are the main and permeable part. These formations are to 2000 m thickness. A specific karstic morphology occurs over their outcrop area. A secondary porosity, due to the dissolution of the carbonated cement of the conglom-

erates, was also identified. The aquifers discharge diffusely or through concentrated sources, either isolated or grouped. The cumulated discharge of the sources often exceeds 100 l/s.

The outcrop area of Babele Sandstone exhibits a relatively even relief, with incipient exokarstic elements. In this case too, the dissolution of the carbonated cement results in good transmisive proprieties. It follows that these sandstones may act as recharge areas of the aquifers located within the conglomerates. As a consequence, it can be assumed that the recharge of the conglomerates aquifer occurs over a total 85 km^2.

The supply of the aquifers is achieved either diffusely or through individual or grouped swallets (ponors). Their development has been most likely favoured by the cracks network, associated to the major fractures. The ponors are generally present along the glacial valleys, stream valleys, temporary or perennial courses. In this respect an important zone is Dorului Valley, which supply several important springs from the eastern mountain-side (Fig. 1: sources 13 - 18).

The major E-W striking fault system identified in the central zone of the massif possibly controls the organisation of the aquifers.

The local erosion level, represented by Ialomiţa Valey and its tributaries, controls the discharge of the aquifers located on each side. In the central eastern zone, the sources 1, 2, 3, 4, 5, 6 (Fig. 1) correspond respectively to the aquifers of Doamnei - Obârşia , Bătrâna, Strungile Mari and Tătarului Mountains. Downstream Ialomita Valley, discharge at the contact zones of permeable and impermeable formations also occurs. The most important group of springs in Bucegi Massive is Şapte Izvoare Reci (Fig. 1: source 7) through witch the aquifer located in Zănoaga - Dichiu Mountains discharges. Other significant sources of the south-western part of the massif occur in Orzei Gorge (Fig. 1: source 8) and Brătei Gorge (Fig. 1: source 9) that discharge the aquifer of the Lespezi Mountain. Finally we mention Rătei Spring (Fig. 1: source 10) through which the southernmost limestone occurrence discharges. The main supply (70%) of the aquifer associated to Rătei Spring includes the ponors developed upstream, either on Rătei Valley or in streambeds of its tributaries at the contact between impervious conglomerates and limestone. After the underground stream course formed in these way follows passage of Rătei Cave of 700 m length (T. Orghidan et al., 1984) it is tapped for the town of Târgovişte water supply.

On the eastern mountainside of Bucegi Massif, the location of sources is directly conditioned by the contact zone between the Bucegi Medial Conglomerates and the upper part of the flysch. Upstream of the springs, the valleys are dry. Most of the sources have been collected for the water supply of Buşteni and Sinaia towns and other touristic village from Prahova Valley.

The location of the sources in the North – West of Bucegi Massif (Fig 1: 20 - 23 sources) has been also conditioned by the contact zone between permeable and impermeable formations (limestone and respectively crystalline schists).

The permeable Bucegi Lower conglomerates occurring in Velicanu Mountain, wich Border to the North the Bucegi Medial Conglomerates, favour an important drainage toward the detritic deposits which outcrop over a large area in Sohodol zone.

The key water supplies in Bucegi Mountains are in the high reservoir of Ialomiţa river, upstream the tectono-morpholigical area of Orza, and in the

Figure 1. Hydrogeological map of the Bucegi Massif

Legend:

Permeable deposits:

1- Argillaceous sands and gravels of Lower Pleistocene age (Qp1);

2 - Sandstones and conglomerates of Upper Cretaceous age (C3);

3 - Calcareous sandstones and conglomerates of Albian age (al);

3.1.Babele sandstone formation (BS);

3.2. Bucegi Upper Conglomerates (BUC);

3.3. Bucegi Medial Conglomerates (BMC);

4 - Clastic deposits of Aptian age (ap);

5 - Limestone of Upper Jurassic age (J3).

Practical impermeable deposits:

6 - Cretacic (C);

6.1 - Marly - clay deposits of Upper Cretaceous age (al);

6.2 - Conglomerates of Albian age (ne-ap);

7 - Geological boundary;

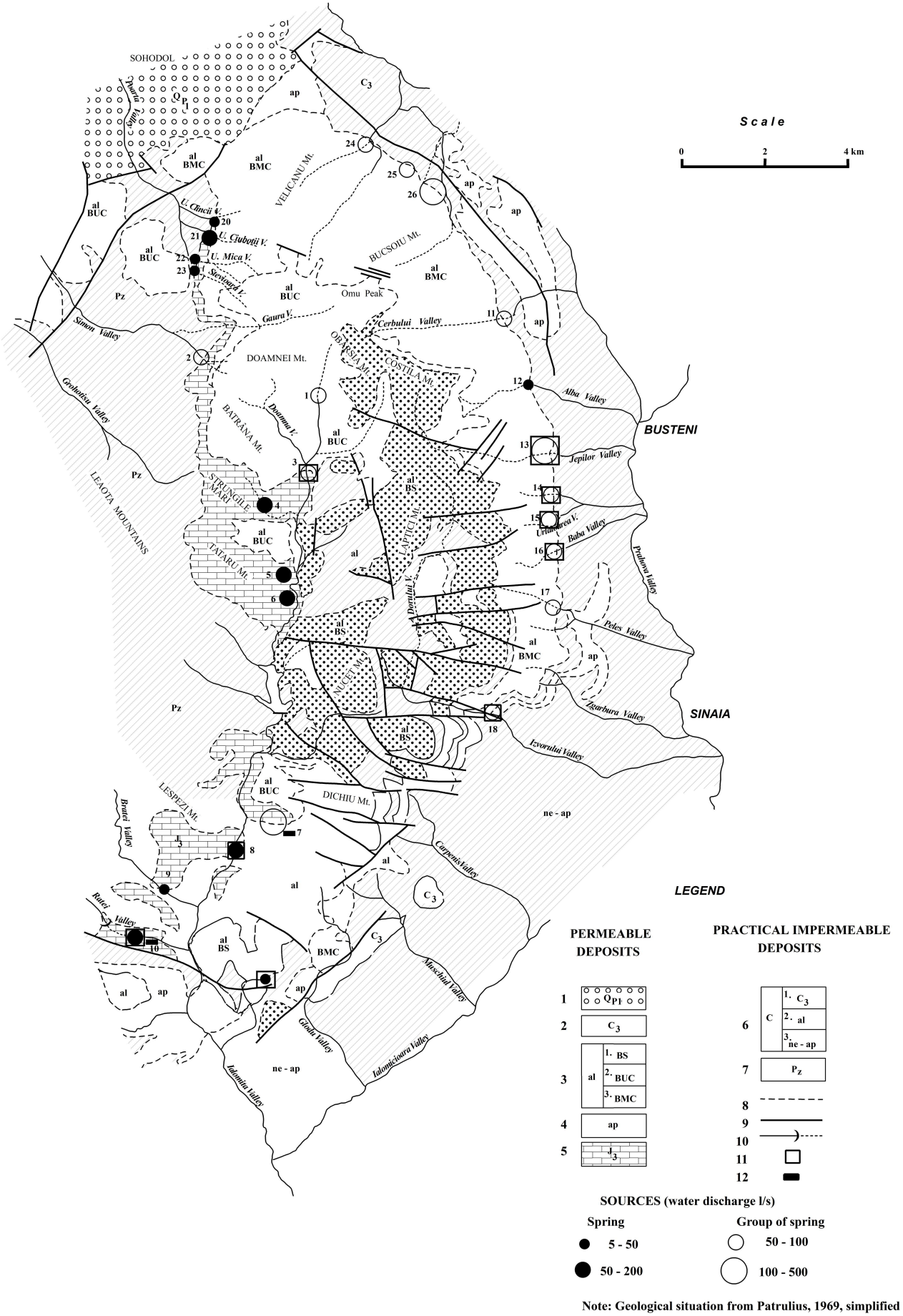
8 - Geological boundary;

9 - Fault;

10 - Swallet (ponor);

11 - Caught source;

12 - Polluted source.



Note: Geological situation from Patrulius, 1969, simplified

Western area of Prahova river. They represent drainage areas of two major hydrostructures of karstic nature: the hydrostructure in North Bucegi and the hydrostructure at Cheile Tătarului - Scropoasa. The two hydro-structures are characterized by geological, structural and hydrogeological features.

Bucegi North structure is rather overlapping over what was called "Bucegi sinclinorium" in between Gaura - Obârşia Mountain and Tătaru Mare - Lăptici Mountain, whose filling is made of limestone deposits of jurassic and classical deposits of cretacic. It is delineated at the bottom and the West by the structure of the crystalline bottom of Leaota, configured like a general monocline, falling from the West to the East, with structural uplifts added later (Horoaba, Cheile Tătarului), and splits also oriented from the West to the East.

Hydro-geologically, the hydro-structure is defined by the underground watershed and drainage areas. Ground watershed is probably centred on Gaura - Obârşia - Omu area, being marked by Ialomiţa spring and diffuse discharging area of Doamna Bătrâna, Obârşia mountain slopes. To the South, erosive-tectonic karstic springs such as Horoba, Păstrăvărie (Cheile Tătarului), Coteanu are added. The main area of drainage is placed on the Western side of Prahova in between Seaca valley and Peleşului valley, at the contact of conglomerates in medium Bucegi and Brecia with Raciu with the neococomian flisch of Sinaia layers. This spatial disposition of drainage areas lead to a general flow from the West to the East.

Cheile Tătarului - Scropoasa hydro-structure is placed in a highly transversal fractured sinclinorium, where Bolboci and Zănoaga - Scropoasa bassins are delineated. This is a structure with an axis directed to the East, under the albian coverage (Albian basin) and whose maximum deepening is at Zănoaga tectonic graben, where the aquifer reaches depths of 300 m.

The flow of underground waters is in a mixed area of permeability, of jurassic limestones and high Bucegi conglomerates, and the drainage direction is to the South.

The main area of drainage is in Scropoasa - Colţii Dichiului series of springs, also know in local toponymy as "Seven springs". The hydro-structure has a secondary drainage area, of a diffuse nature, placed in Valea Dorului, a tributary of Prahova, at the contact of high Bucegi conglomerates with the facies of Scropoasa - Lăptici.

The intersection of emergence areas in Bucegi leads to a division of the two hydro-structures from "cuesta" of Bucegi to the tectonic rise of Cheile Tătarului.

We need to add another hydro-structure of a karstic nature delineated at the level of Raciului sinclinorium, the most Southern one in Bucegi Mountains. Its filling is made of Brecia de Raciu in Valea Ialomiţei (Gâlma springs in Valea Ialomiţei), plus conglomerates of high Bucegi to the West, in Ialomicioara valley at Runcu (Tâţa springs in the valley with the same name, Ialomicioara spring, South to the intersection of Vaca with Frumuşelu valley). Brecia de Raciu contains about 90% Jurassic limestone and partial Triassic ones, plus crystalline elements.

The supply of the aquifers derives mainly from the snowmelt and from the melting of seasonal glaciers, since the recharge area is located at about 2000 m elevation. The temperature of the springs is 3-5°C. The general chemical type of the water is calcium – carbonate. The chemical analysis of the sampled sources indicates low values of the total content of dissolved salts (between 166.5 and 347.9 mg/l) with an exception at Rătei source. In this case, the increase value of 603 mg/l is originating partly in looses of Rătei epigean stream, which crosses the crystalline schists before sinking in ponor.

According to vulnerability to pollution, three sectors can be separated in Bucegi Massif.

The sector North of Gaura Valley - Cerbului Valley lineament is not polluted. In this sector anthropogenic activity is generally difficult, because of high altitude and steep relief. Glăjeriei spring (Fig. 1: source 25) and Ascuns spring (Fig. 1: source 13) have the best hydrogeological environment conditions to be promote like natural mineral water.

In the northern sector of the Dichiu Mountain - Izvorului Valley lineament, pollution hasn't reach yet the discharge zone of the aquifers. Some pollution sites, buildings and intensive sheep breeding areas are present. Strict regulations concerning the storage of garbage, the neutralization of sewages and the establishment of natural reservation zones are required.

In the sector South of Dichiu Mountain - Izvorului Valley lineament, a pollution of "Şapte Izvoare Reci" source occur from seepages throughout the adduction tunnel of the water from the Bolboci Lake to Scropoasa hydroelectrical generator.

Conclusions

1. The before discussed aquifers generally have a great potential for public water supply and still natural mineral water.
2. The springs are points of discharge of fragmentary aquifers. As a consequence, it is improbable that a hypothetical pollution may spread over large areas.
3. As a general rule the aquifers of the Bucegi Massif are not polluted but the lack of impermeable, protective layers, increases the vulnerability to pollution of the most important aquifers.
4. The Bucegi Massif also presents a great touristic attraction and the immanent developing of the touristic sites should not affect the very good quality of the water. The establishment of natural reservation zones are required.

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