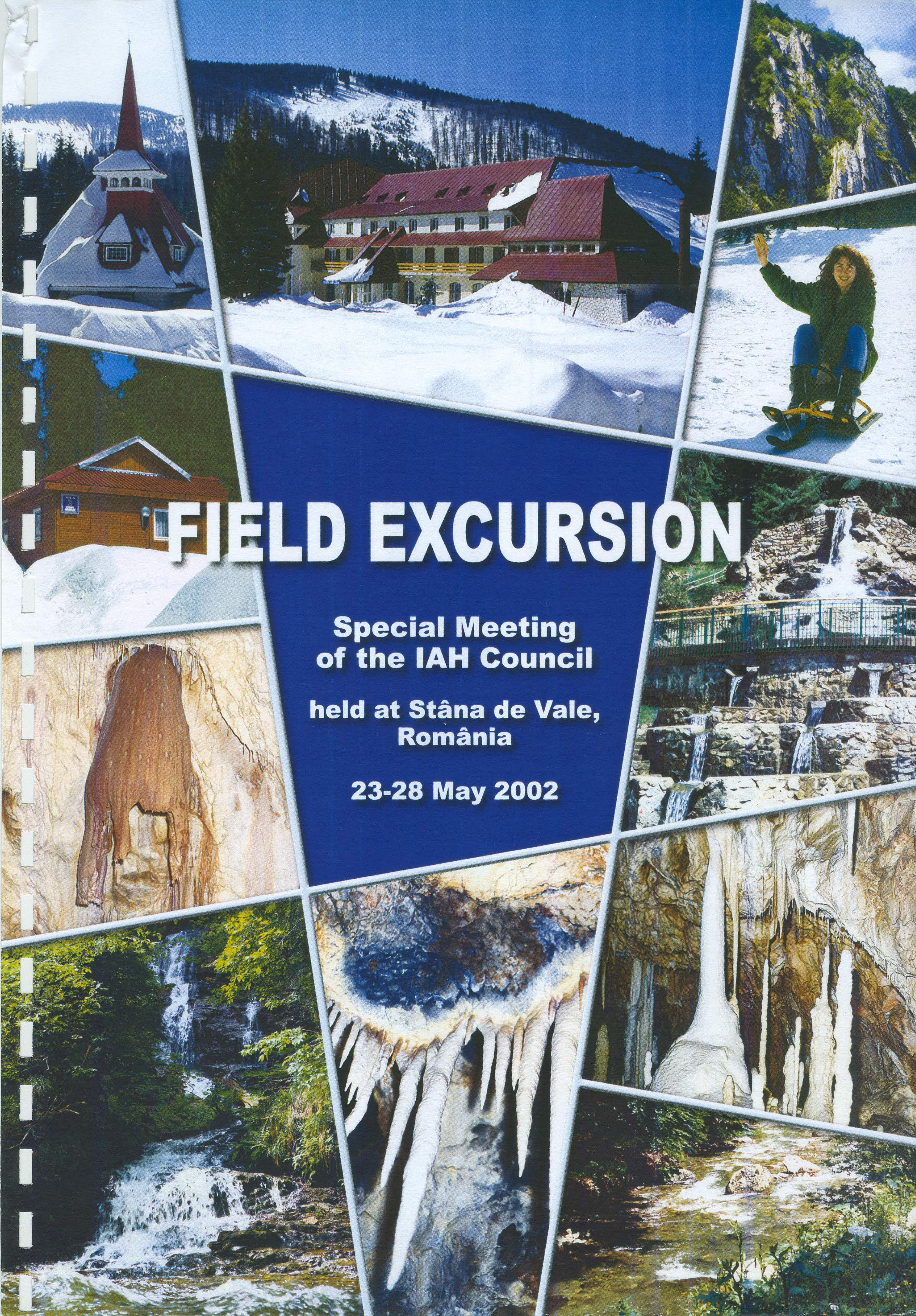

FIELD EXCURSION

Special Meeting of the IAH Council

held at Stâna de Vale, România

23-28 May 2002

ASOCIAŢIA HIDROGEOLOGILOR DIN ROMÂNIA
ASSOCIATION ROUMAINE DES HYDROGEOLOGUES
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Edited by *Romanian Association of Hydrogeologists*
Sponsored by *European Drinks*

CONTENTS

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NOTE: Guide of field excursions 2 and 3 is a compilation of several texts and figures published by various authors either as independent articles or as a part of other field guides. A list of references used in this compilation is available at the end of this booklet.

Field excursion 1

STÂNA DE VALE AREA. IZVORUL MINUNILOR SPRING AND TUNNEL FOR MINERAL NATURAL STILL WATER TRANSPORT

Introduction

The excellent reputation of Stâna de Vale climate resort is due both to its exceptional tourism potential and to the outstanding qualities of the water of Izvorul Minunilor. Known ever since the oldest times, due to their „pure air, very good water and shadow of the fir trees forests“[1], these places became an object of interest for the public starting with the year 1879, when the bishop Mihai Pavel, by declaring itself being „delighted by the beauty of the place, expressed its will to build there a bathing facility with baths treatment“[2]. During the next years there started the construction of the first facilities, the first hotel (1883), later named Siberia, the restaurant Elisabeta (1884), the Church Chapel and other modest cottages (1886), the first image of the mountain resort taking shape, in a manner specific to the end of the past century and of which no testimony has been preserved“[3]. In the year 1886 Izvorul Minunilor was used for the supply of the „big shower“, also called the „cold bath“[4].

„The number or the tourists had exceeded 300 on 12 August 1888“[5], while in the year 1890 the resort possessed 60 „rooms“, as well as other facilities (restaurant, promenade, separate salon for dancing, „baths edifice“)[6]. On 1 June 1890 there takes place „The inauguration of Stâna de Vale“, situated „in the most romantic part of Bihor Mountains, surrounded by a huge fir trees forest“[7].

The development of the resort has been favored by the completion of Oradea-Ceica-Beiuş-Vaşcău railroad, commissioned in the month of June 1887, of Budureasa-Stâna de Vale road (1892), and of Valea Iadului-Stâna de Vale alpine railroad, completed in the month October 1934, and about which Iosif Vulcan was writing „It is something like in the flying carpet tales, you get into the small railway inspection car and led by a brakes-man you fly above the forests, piercing the mountains, defying the peril. And so you descend 45 km down to the railway station, at Valea Iadului, without requiring any mechanical propulsion“[8].

In the year 1928 Stâna de Vale is awarded the statute of "climate resort“, granted by the Ministry of Health and Social Protection, by the General Balneology-Climatic Inspectorate, as well as by the Bihor County Hygiene and Public Health Council. During this period the resort had a „system of Swiss cottages, built in wood, with 1-8 rooms, a total of 150-200 places, provided with all the necessary facilities. Since two years considerable investments have been completed: the new bishopric residence (22 rooms), aqueduct running from the famous Izvorul Minunilor, the most fortifying water in the surroundings, electric light produced by a modern turbine and fir tree baths, hydro-therapy installation; neither is absent the beautiful lake with trouts and gondola“ [9].

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1 Familia, 1890, no. 19, p. 228
2 Familia, 1880, 8 ,p. 48
3 V. Faur, D. Cluciu , 1983)
4 Familia, 1886, no. 31, p. 376
5 I. Vulcan, Stâna de Vale, in Familia, no 31, p. 357-358
6 Familia, 1890, 19, p. 228
7 Familia, 1891, 19, p. 228
8 M. C. Samarineanu, Stâna de Vale, in Familia, 1935, no. 7-8, p. 112-114.
9 Familia, 1891, 19, p. 228

In the year 1928, because of old buildings becoming increasingly deteriorated, there has started the construction of the hotels Belvedere (with 13 rooms) and Excelsior (with 56 rooms) that complied even with „the most delicate requests“[10], by extending over the entire year the possibilities of using the resort. In the year 1933, the Bihor Tourist Club sheltering house has been built, with 30 beds included.

Iosif Vulcan, in the opening of his article about the trip to Moara Dracului in the year 1892, was expressing the following comments: „Bihariei Mountains are rich in beautiful places. The tourist, as well as the artist and the scientist can find here a multitude of subjects to be admired and studied. In spite of this, people still do not know them well, for accessible ways of communication being almost entirely absent, it is quite small the number of those who warmed up by the fire of the enthusiasm for the beauties and the specificities of the nature, ignore all the drawbacks and difficulties, and start on horseback or on foot, across thousands of tiresome obstacles, only to see or study this or that site or rarity of the Creation“[11]. Among those who contributed to discovering picturesque places, Iosif Vulcan mentions Iuliu Czaran, land-owner from Sepreuş (Arad county), „who spends every summer at Stâna de Vale, where he carries out frequent trips across the mountains, the valleys and the caves in the environs. He has discovered many sites that gave rise to bewilderment, marvels of the nature, worth attracting the attention of cultivated people“[12]. Iuliu Czaran graduated the law school and he gathered in a book the detailed description of 33 tourist trips performed in Bihor Mountains (1903), and in another book the Legends of Stâna de Vale.

Wilhem Matyas, in „The tourist guide in the surroundings of Stâna de Vale“ (1936), has published one of the legends of these places, the legend of Izvorul Minunilor: „*The legend says it that in the old times there was here, below the ground, a strong empire of the ice floes. The emperor had a daughter beautiful like a fairy, and he had cautioned her that she should elude the fire of love. Yet the girl did not listen to his fathers warning and thus, under the hot love of the emperor of the Fire Land, the ice pillars which supported the stone vaults of the strong empire melted, also burying under their ruins the couple of lovers. The traces of this huge mountain collapse are still visible in our days in the stone slabs that are strewn everywhere. While the cold as ice water of the melted strong underground empire keeps on flowing out from the heart of the earth, still in our days*“.

1. Topography, hydrology and climate data

The climate resort Stâna de Vale is situated in the central-western area of Vlădeasa Massif, in the middle of the catchment area of Iad stream, a tributary of Crişu Repede stream. The catchment area has a circular shape, covering a surface of 8 km^2, and it has 1233 m average elevation. It is bounded to the southwest by the catchment area of Crişu Negru stream (Beiuş Basin), by the ridge Băiţa peak (1352.0m) - Custurilor peak (1386.4m) - Poienii peak (1626.8m), while Baia Popii ridge, of 1400 m average elevation, separates it to the west with respect to Drăganului catchment area.

Across the depression there run the streams Băiţa, Custuri, Trauri, Fântâna Galbenă with its tributary Piciorul Galbenei, Rampei, and Ariei with its tributary Baia Popii. We mention the fact that when reaching the Anisian dolomite substratum, the water of the last mentioned course completely sinks through several swallets that in terms of human exploration are impenetrable. During snow melt and heavy rainfall the absorbing capacity of these swallets is exceeded, and as a consequence, also the valley section that extends downstream carries temporarily water.

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10 Appendix no. 6 to Memoriu, 1935 (1936)
11 I. Vulcan, Trip to Moara Dracului, in Familia, 1892, 35, 416-418
12 Ibidem
Note: quotations have been extracted from V. Faur, D. Cluciu, 1983, 1985 and 1989

The climate of the area is of continental temperate type, in the domain of influence of the western circulation that carries wet and cold masses of oceanic air.

The 1950-2000 multi-annual average of the rainfall recorded at the INMH meteorological station within the resort is 1563.3 mm. June is the most rainy month at Stâna de Vale (data over the 1950-1999 period), with 12.6% (197.2 mm) of the multi-annual average rainfall occurring during this month. The most dry months are February and March, with 6.7% (104.5 mm) and 6.0% (93.97 mm) respectively of the multi-annual average. The multi-annual average rainfall amounts, distributed as a function of the warm and the cold seasons, namely over the time interval May-September and October-April respectively, are relatively similar (47.8%, and 52.2 % respectively).

The multi-annual average air temperature at Stâna de Vale is 4.6 ^{o}C, the maximum values being recorded in the months of July (13.2 ^{o}C) and August (13.7 ^{o}C), and the minimum ones in the month of February (-3.9 ^{o}C).

The vegetation that prevails in the domain consists of fir tree, spruce and beech forests, that on the ridges are replaced by alpine grasslands.

In Custurilor peak area, due to the steep and large elevation range topography, the runoff regime closely mirrors the rainfall regime. The heavy rainfall or the fast snow melt periods are accompanied by significant increases of the stream courses discharges, while drought periods lead to severe reductions of these flow rates.

2. The geological structure

The geological structure of Stâna de Vale area is extremely complicated, with sedimentary deposits in overthrusted structures belonging to the Codru nappes System (the Ferice and Arieşeni overthrusts), pierced or overlain by the Vlădeasa igneous body rocks (fig. 2). Areas of significant extent are occupied by sedimentary and volcanogene-sedimentary deposits of Senonian age, transgressively deposited over the older sedimentary structures and igneous formations, being synchronous to, or overlain by the upper terms of the Banatitic eruptions.

2.1 Sedimentary deposits

Ferice Nappe. This tectonic unit consists of Triassic and Jurassic formations, that include the following lithologic succession (Bordea, 1998):

Skythian. Deposits of this age consist of very hard, layered, gray or greenish quartzite sandstones, having a thickness of about 200 m.

Anisian formations consist of gray dolomites, well layered in sub-metric beds, similar to those of the Arieşeni overthrust. The deposits are about 150 m thick.

Late Norian - The Codru Formation - consists of gray shales alternating with siltstones, in which dolomitic limestone with brucite occurs. The estimated thickness of this formation is 250 m.

Early Rhaetian - The Valea Frunzei Formation - includes beds of dolomitic limestone with megalodonts, carbonate sandstones, siltstones, carbonate conglomerates and clays, the entire series having a thickness of about 350 m.

Late Rhaetian -The Kossen formation - consists of a black, layered limestone, that hosts a rich fauna of brachiopods and corals. 25 m maximum thickness.

Early Jurassic, consists of marly clays alternating with spatic carbonate sandstones and marly limestone with belemnites. About 250 m thickness.

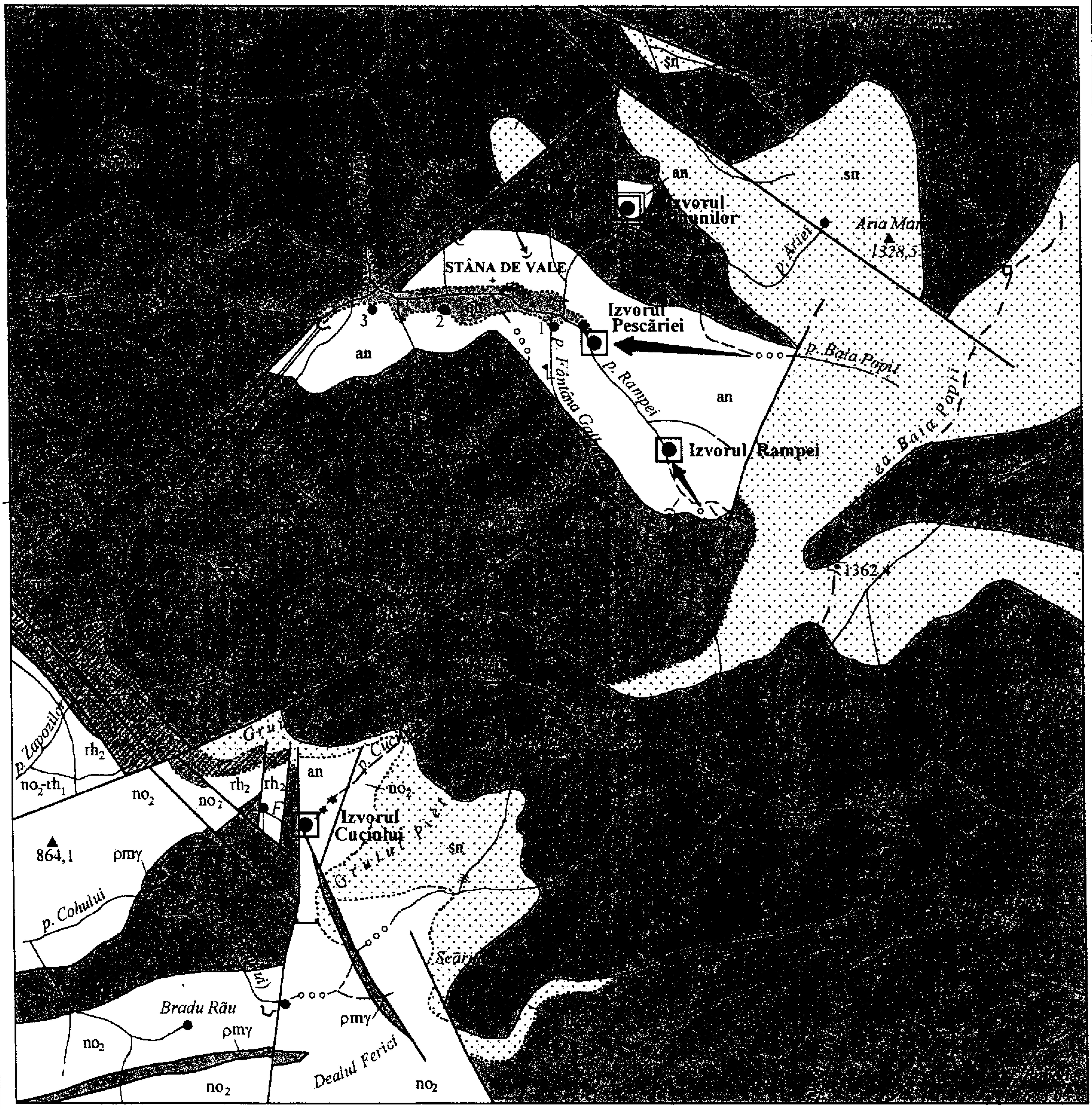
The Ferice overthrust deposits outcrop in the south-western part of the domain, in the catchment areas of Zăpozilor, Cuciului and Valea Rea streams. Deposits of the same overthrust also occur in Aleu stream upper catchment area. They lay over the Banatitic body or over the Jurassic or Cretaceous deposits of the Bihor Unit, and they are partly

Figure no. 2

Iancu Orăseanu

HYDROGEOLOGICAL MAP OF THE STANA DE VALE AREA

0 0.5 1 km



LEGENDE

- Holocene alluvium
- Laramian magmatites:
  - ρmγ Microgranite rhyolite;
  - δQ Quartz diorite
  - To Tonalite
  - ρ^V Vlădeasa rhyolite
  - ρ^C Ciripa rhyolite
  - ν Dacite
  - α Quartz andesite
- Senonian in Gosau facies
- Jurassic limestones and marls
- Triassic limestones and dolomites
- Permo-skithian sandstones

- Losses in flow along the riverbed
- Ponor
- Spring
- Tapped spring
- Still water spring
- Proved groundwater flow direction
- Watershed
- Tunnel for water pipe
- Weather station
- Water level recorder
- Waterfall
- Sheepfold

Note: Geological data after S. Bordea, 1999, and G. Istrate, 1978.

overlain, in an overthrust setting, by the quartzite sandstones of the Arieşeni overthrust or by the Vlădeasa rhyolites.

The Arieşeni Nappe. Permian and Early Triassic formations have been distinguished within this tectonic unit.

Permian formations include detritic, continental streambed deposits of red color, with feldspar (the Feldspar Formation) or with worms imprints (the Vermicular Formation). 200 m thickness.

Skythian formations include well layered quartzite sandstones and conglomerates, with sparse intercalations of red or greenish shales. 150-500 m thickness.

Anisian formations consist of gray dolomite and dolomite breccia, with a thickness of 150 m.

2.2 Alpine subsequent igneous rocks (Banatites).

Vlădeasa igneous complex occurs in a subsidence area of graben type, the ascending magmas following the fractures systems of the Crystalline-Mesozoic basement. The igneous activity resulted in the emplacement of a sequence that includes a multitude of intrusive rocks, consisting of andesites and of a series of dacites and rhyolites solidified subject to sub-volcanic conditions. Subsequently, there have been emplaced intrusions of micro-diorites, diorites, porphiric granodiorites, granodiorites, granophires, microgranites and granites.

Rhyolitic rocks of Vlădeasa Massif, designated by D. Giuşcă (1950) as the "Vlădeasa rhyolites", and by G. Istrate (1978) as the "ignimbritic rhyolites formation", occur under various facieses, that range from eutaxitic (flow textures, ribbon-like) to compact, vitrophiric, up to pyroclastic with volcanic tuffs and many xenoliths, depending on the way the rhyolitic magma solidified, namely beneath the Senonian sedimentary cover or at the surface.

The Banatites intrusion has generated contact phenomena within the sedimentary deposits it crossed. At the contact between Banatites and limestone, there have been generated marbles and various types of calcic skarns, while at the contact with detritic and pelitic rocks there have been generated hornfels, skarns with garnets, etc.

Within Stâna de Vale area, the most frequent igneous rock types are as follows:

- the Ciripa rhyolites, are ribbon-like rhyolites displaying an eutaxitic structure and a broad crystallization of the main mass.
- the rhyolites with ignimbritic structures, the Vlădeasa rhyolites, occur subject to a variety of structural and textural appearances. They are gray colored and their facies is massive or eutaxitic (finely vesicular and non-homogeneous magma), less frequently pyroclastic or of breccia type (of explosion).
- the tonalites are intrusive rocks, representing the transition between granodiorites and diorites. They have a holocrystalline structure and massive texture, a dark color and they form a large extent body, with deep "roots", in the area of Băiţa peak, in the north-western part of the domain.

2.3 The post-tectonic cover

Senonian deposits, occurring in a Gossau facies, form the Late Cretaceous post-tectonic cover of the Bihor Unit and of Codru nappes System. These deposits outcrop on relatively large areas east of Stâna de Vale resort.

G. Istrate (1978), in his work dedicated to the petrographic study of Vlădeasa Massif (their western section), distinguishes within the Senonian deposits a lower sedimentary complex and a volcano-sedimentary formation. The lower sedimentary complex - the Gossau formation - is largely represented in the northern part of the mountains body, where crystalline schists are overlain by a succession that includes three horizons: a conglomerate one at the bottom, a marly-sandy, micaferous one in the median position, and a micro-conglomerate one at the top.

The volcano-sedimentary formation deposits consist of a variable ratios mixture of sedimentary and igneous material, including tuffites, tuff-breccia and volcanic conglomerates, sometimes reaching thicknesses of 100-150m.

2. 4 Tectonics of the area

The Anisian dolomites of the Arieşeni overthrust occur in Stâna de Vale area within a syncline structure, with Skythian quartzite sandstones at the bottom, and with the micro-conglomerate sandstones and clays of the Senonian transgression covering it in the north-eastern part. In the south-western part of the area, the continuity of the Arieşeni overthrust deposits is broken by the fault of Custurilor peak, that strikes approximately NE-SW and has its south-eastern compartment down-thrown, with Anisian dolomites on Cuciului stream outcropping in it.

The Arieşeni overthrust deposits are crossed by the tonalites rooted body of Băiţa peak and by the quartz diorites in the area of Izvorul Minunilor. Within the ridge Custurilor peak - Poienii peak and north of Stâna de Vale resort, they are covered by the Vlădeasa rhyolites, the contact between the Triassic deposits and the igneous formations being frequently marked by the Senonian deposits that rhyolites overlie. The contact between the Anisian dolomites in Stâna de Vale area and the Vlădeasa rhyolites occurring to the north, is a tectonic one, consisting of a NW-SE striking fault, with its north-eastern compartment down-thrown.

3. The hydrogeologic setting of Stâna de Vale area

The important tectonic actions to which the formations included in the geological composition of the south-western part of Vlădeasa Massif body had been subjected, have resulted in of a kaleidoscopic distribution of rocks, in which formations with distinct lithology compositions are brought into direct hydrogeological connections, generating aquifers with specific groundwater recharge, flow and discharge conditions, that supply springs of high bacteriological purity and outstanding chemical qualities.

The genesis of the main springs in the south-western part of Vlădeasa Massif (Izvorul Minunilor at Stâna de Vale and the springs Cuciului and Pescăriei), is related to the occurrence of carbonate rocks, the latter behaving as conduits for the water accumulations located in the other rock types. Limestone and dolomite are largely developed in the basement of the area, yet they outcrop over restricted surfaces, because both Senonian deposits (consisting prevalently of sandstones, conglomerates and shales), and Vlădeasa rhyolites cover them to a large extent. The entire rocks series is pierced by intrusive rock bodies having penetrated along fractures.

The dolomite plate in Stâna de Vale area (fig. 2), being positioned below the mountains that surround it, concentrates the runoff from the adjoining, non-karst hill-slopes, which results in binary karst systems being set up. The recharge of the karst aquifers of these systems is derived both from surface stream courses, whose water sinks in the underground either fast, through swallets (the swallet in Baia Popii stream and the swallets beneath Piciorul Plaiului), or in a diffuse manner, through the alluvia in their stream-beds (Fântâna Galbenă, Pepinierei and the brooks in the upper catchment area of Rampei stream), and by the underground flow occurring within the entire contact zone between dolomites and adjacent rocks. Aquifers hosted by the Senonian deposits and/or by Vlădeasa rhyolites overlie the karst aquifers, and as a consequence the latter are warranted both a constant recharge, and a protection resulting from filtering of the superficial, rainfall derived waters.

The groundwater accumulations in the Anisian dolomites in Stâna de Vale area discharge via three main outlets: Izvorul Minunilor, Pescăriei spring and Rampei spring. Beside these ones, there are a few other springs with small flow rates, such as Păcii (fig. 2, no. 1), Radu (no. 2) and Pavel (no. 3) springs.

The Skythian quartzite sandstones display groundwater accumulations in their alteration zones, marked by a multitude of springs with flow rates up to 1 l/s, such as those along Ariei, Trauri and Pepinierei streams, and Brăesei spring (fig. 2, no. 4). The crushed zones that accompany the main faults occurring within the Skythian sandstones may act as conduits for the groundwater in their alteration zone and in the adjacent deposits. In this respect, one example is met in the tunnel excavated for setting the pipes required in order to convey the water from Stâna de Vale to Rieni.

Rhyolite rocks host groundwater accumulations as well, as indicated especially by the springs occurring in the upper reaches of the valleys excavated in these rocks: Ariei (fig. 2, no. 5), Groapa Onului (no. 6), Plodul Babei (no. 7), spring of Cuciului brook (no. 8). These springs have average flow rates that may reach 1-3 l/s, a generally neutral, yet occasionally acid pH, the latter instance occurring as a consequence of the oxidization undergone by pyrite strewn within the rock mass (e.g. Fântâna Galbenă spring, pH=3.6, fig. 2, no. 9). The water of these springs is of calcium bicarbonate type, with 60-80 mg/l TDS contents.

4. Izvorul Minunilor spring

Izvorul Minunilor spring emerges from a small outcrop of Anisian dolomites, surrounded by Skythian and Senonian deposits and by Vlădeasa rhyolites (fig. 2). Although in the area of Izvorul Minunilor spring the dolomites outcrop over a very small surface, they are largely developed within the basement, acting as a conduit for the groundwater accumulations located within the overlying formations, that prevalently consist of Senonian deposits (sandstones, clayey sandstones, conglomerates, marls) and of Vlădeasa rhyolites. These formations exert a twofold hydrogeological role, both by securing a strong a constant supply to the carbonate aquifer, and by providing it with a protection against fast recharge with surface-derived water, that is likely to be charged with mineral suspensions and with bacteriological loads.

In the year 1995 the spring had a 15.6 l/s average flow rate, with a very small variation (nv=1,9) (Orăşeanu, 1998). Over the January 2001-April 2002 period, the spring had an average flow rate of 26 l/s, with fluctuations ranging between 15 and 38 l/s (A. Feru, oral information). Strong rainfall does not induce a significant increase of the spring flow rate, although it leads to the aquifer stored reserves being increased. The karst system has an inertial character, being highly efficient in storage terms and very poor in transmissive terms.

The water of Izvorul Minunilor outlet is of calcium bicarbonate type, with a very low TDS content (table 1), having a neutral - slightly alkaline character, it is non-radioactive, pure from a bacteriological point of view, colorless and it tastes good.

The investigations addressing the behavior of Izvorul Minunilor outlet water chemical constituents, performed both on water samples collected from the spring and stored during 5 months in the laboratory (Pascu et al, 1984), and by geochemical computer modeling which has simulated storage temperatures as high as 50°C (Feru A., Ruxandra Slăvoacă, 1998, I. Orăşeanu, 2000), have indicated a very good stability of the water chemical composition.

As a consequence of the outstandingly constant values of its physical-chemical parameters, and of the permanent absence of any bacteriological load, Izvorul Minunilor at Stâna de Vale ranks as one of the best sources of non-carbonated natural mineral water (still water) in Romania.

Izvorul Minunilor outlet has been certified as still water in the year 1984. In the year 1990 RAMIN (SNAM) has been appointed its administrator. This company has subsequently financed the building of the present-day intake, based on the design of I. Vernescu, the actual works being completed by the HIDROCON company in Lugoj. During the period 2000-2001, the company European Drinks S.A. has built a 27 km long stainless steel conduit, down to the bottling factories at Sudrigiu and Rieni. In the year 2001 the spring has been once more certified by ANRM, and by the Exploitation License no. 2643/2001, ANRM has granted the license for the exploitation of the water of Izvorul Minunilor by bottling, the actual exploitation having started in the month of August 2001.

5. Tunnel for mineral natural still water transport

Izvorul Minunilor tunnel has been excavated by the company Minexfor S.A. Deva during the period 01.06.2000-13.02.2001. The work has been completed at the request of the European Drinks S.A. company, for setting the pipes required in order to convey the still natural mineral water of Izvorul Minunilor to the bottling factories at Sudrigiu and Rieni. The work is 1146 m long and it runs beneath Custurilor ridge, connecting the Iad and Crişul Negru streams catchment areas.

The tunnel is excavated in Anisian gray dolomites on its first 172 m, then further on, down to the length of 913 m, in quartzite sandstones with occasional clay intercalations. Over the length interval 913-1123 m, there have been crossed coarse quartzite micro-conglomerates alternating with gray micaferous quartzite sandstones and red shales, while over its last 23 m (from 1123 to 1146 m) the work has crossed a stack of hard, coarse quartzite micro-conglomerates. The entire series crossed by the tunnel from 172 to 1146 m is ascribed to the Skythian (Teodor Micula, 2002, Transilvania General Import-Export Archive, Oradea).

During the tunnel excavation, several water inflows have been intercepted on fractures and cracks that occur within the quartzite sandstones, so that by the present time their cumulated flow rate amounts to 12 l/s. There occur both concentrated inflows, along well defined fracture zones that have been subsequently excavated into 1 - 1.5 m deep stable holes (e.g. m. 600 N, m. 620 S, m. 680 S, m. 900 N), and diffuse seeps, through the cracks networks in the ceiling and the walls of the tunnel (e.g. m. 575-600, m. 855-865). The water is collected in the tunnel gutter, being gravitationally discharged to the surface through the two entrances. Groundwater running through the tunnel is of calcium and magnesium bicarbonate type, with very low TDS content (table 1).

Conclusions

The geological-structural setting of Stâna de Vale area, with carbonate deposits embedded in a "mosaic" next to other sedimentary deposits (sandstones, marls, shales, conglomerates) and igneous rocks (rhyolites, tonalites, etc.), have created an outstandingly favorable substratum in terms of very good quality water aquifers. By adding to this the favorable opportunity of a basement including an established reservoir rock, the limestone, highly efficient in transmissive storage terms and less in storage terms, and of an overlying aquifer, potentially efficient in storage terms, yet not very conductive, the Senonian deposits and the Vlădeasa rhyolites, we get the picture of the retort where the wonder water of Izvorul Minunilor was elaborated.

Table no. 1
Chemical composition of springs in Stana de Vale area*

Spring	t	ph	Cl	NO_2	NO_3	SO_4	HCO_3	Na	K	Ca	Mg	RF	DT	TDS
	°C		ppm										°ger	ppm
Izvorul Minunilor		7.6	8	0.02	3.9	27.3	122	1.1	0.8	22	4.9	80	3.9	
Pescăriei	5.4	7.67	3.5	0	1.7	0	122	0.8	0.4	28.1	8.5	140.8	5.9	202.8
Rampei	5.2	7.81	3.5	0	2.7	0	109.8	0.4	0.4	20.0	10.9	125.7	5.3	172.3
Cuciului	6.5	7.98	3.5	0	2.7	0	73.2	0.6	0.5	26.1	0.0	101.8	3.6	136.4
Tunnel, m. 900	7.4	6.2	1.8	0	0	19.1	27.21	0.7	0.8	9.9	2.7	61	2	92.0
Podu Cuciului, 10	9.2	7.1	3.5	0	0	0	106.2	0	0.2	33.1	2.3	93.5	5.2	166.9
Fântâna Galbenă, 8	6.0	3.64	3.5	0	0	sld	11.6	0	0.4	5.2	0.2	15.6	0.8	36.1
Izvorul Rece	5.0	4.39	1.8	0	0.1	2.4	6.1	0	0	4.0	0.0	15.7	0.6	35.1
Ob. p. Cuciului, 9			3.5	0	0.6	9.6	20.7	1.6	1.1	8.6	0.0	45.7	1.2	110.3
Izvorul Nou, 11	8.6	7.5	3.5	0	0	0	146.4	0	0	38.0	7.3	158	7	214.5

* Analyses performed in S.C. Prospecţiuni lab., except analyse of Izvorul Minunilor spring performed by SNAM lab. (analyse no. 377 / 14.12.2000).
(Fe) is absent in all analyses

References

Bordea S. (1999): Harta geologică a zonei Stâna de Vale. Arh. IGR, Bucureşti

Faur V., Cluciu D. (1983): Contribuţii la cunoaşterea istoricului staţiunii Stâna de Vale. Crisia, XIII, p. 567-576, Oradea.

Faur V., Cluciu D. (1985): Noi documente despre Stâna de Vale (perioada interbelică). Crisia, XV, p. 243-254, Oradea.

Faur V., Cluciu D. (1989): Din istoricul staţiunii Stâna de Vale. Crisia, XIX, p. 473-486, Oradea.

Feru A., Ruxandra Slăvoacă (1998), Evaluation de la stabilite des eaux preemballees par la modelation hydrochimique. Proceedings of the International symposium "Mineral and thermal groundwater", Miercurea Ciuc / Romania, 24-27 June 1998, edited by Iulian Popa (Romanian Association of Hydrogeologists), p. 97-103.

Istrate G. (1878): Studiul petrografic al masivului Vlădeasa (partea de vest). Anuarul IG, vol.LIII, p. 177-298, Bucureşti.

Matyas V. (1936): Călăuza turistică prin Împrejurimile Stânei de Vale. p. 23-119.

Orăşeanu I. (1996): Contributions to the hydrogeology of the karst areas of the Bihor-Vlădeasa Mountains. Theoretical and Applied Karstology 9, 185-214. Bucharest.

Orăşeanu I. (1998), Hydrogeological researches for still waters in Bihor Vlădeasa Mountains (Apuseni Mountains, Romania). Proceedings of the International symposium "Mineral and thermal groundwater", Miercurea Ciuc / Romania, 24-27 June 1998, edited by Iulian Popa (Romanian Association of Hydrogeologists), p. 213-222.

Orăşeanu I. (2000), Consideraţii privind stabilitatea chimică a apei unor izvoare din zona Stâna de Vale. Lucrările Simpozionului "100 de ani de hidrogeologie modernă în România", 24-26 mai 2000, Bucureşti, p. 375-378.

Pascu M., Moissiu C., Moisescu Alina (1984), L'eau plate - une nouvelle ressource du karst de la Roumanie. Theoretical and applied karstology 1, p. 195-206, Editura Academiei Române, Bucureşti.