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3.13.5. POIENI PLATEAU

(Reprint from Karst Hydrogeology of Romania, 2010)

For the area of the Metaliferi Mountains, given their intense morphological segmentation, a series of rather arbitrary sub-divisions and conventional naming conventions were proposed by geologists and geographers. One of the most used ones is a scheme proposed by M. BLEAHU in "A geological evolution of Metaliferi Mountains" (V. IANOVICI et al., 1969) where the author includes in the Metaliferi Mountains the following sub-divisions: Highiş Mountains, Drocea Mountains, Găina Mountain, Auriferi Mountains, Vinţu Mountains and Trascău Mountains. Given this context, the Poieni Plateau is placed in the Eastern area of Gaina Mountain, to the South of Arieşu Mic river (Fig. 1.1)

The Poieni Plateau extends south of Arieşu Mare river, over an area of 88 km^2, being delimited to the east and south-east by the Sohodol stream, a tributary of Arieş river at Câmpeni, and to the west by Vidrişoara stream, a tributary of Arieşu Mic at Avram Iancu. The southern boundary of the plateau consists of the headwaters of Crişu Alb river (Fig. 5.1).

5.1. Geological data

The Poieni Plateau represents the most extended area of crystalline limestones occurrence (45.5 km^2) in the Metaliferi Mountains. In the close neighbourhood of the plateau, limestones also outcrops south of the headwaters of Crişu Alb (11 km^2) and, on very small surfaces, in the upper catchment area of Uibăreşti stream (1.5 km^2). It overlies a strip of black quartzites and graphitic schists, while its normal immediate caprock is, similarly to all the Medium Paleozoic marbles, unknown, the oldest overlying formations being those of Jurassic age (V. IANOVICI et al., 1976).

The crystalline limestones is widely crystallized, saccharoidal, brittle, of various colours, from milky-white to grey-black, occasionally with pink-yellow tones. It is generally compact, occurring in meter thick beds, yet displaying frequent alternations of decimeter thick or plate-like layers, prevalently of grey, grey-black colours, that provide a stripped appearance. They are roughly 1000 m thick and they have a gentle southward dip. In structural terms, the limestones constitutes the Sohodol marbles series, included in the Baia de Arieş Nappe.

The mineralogical composition exhibits the following contents: 85-90% calcite; 6-7% sericite+muscovite; 3-5% hematite+limonite; 0-1% quartz. The rock structure is granoblastic, while its texture is commonly compact.

5.2. The plateau landforms

Differential erosion, rather weak on the terrains that are covered by crystalline limestones, yet well developed on the terrains adjoining the plateau, led to limestones occurrence in distinct landforms, that resulted from the shaping of an abrasion platform located at 1100-1200 m elevation, which in terms of landforms shaping is ascribed to the Fărcaşa-Cârligaţi Platform (P. COCEAN & VIORICA IFTENE, 1985). Only a few rounded, isolated peaks, among which Ştiubeiul (1326.9 m), the highest peak of the plateau, protrude above this surface.

A specific feature of the topography in this geographic area is the strong contrast which exists between the flat, virtually horizontal appearance of the plateau, strewn with rounded ridges, and the youth of the valleys that surround it. To the north the plateau is delimited by a 300-500 m high bluff facing the Arieşu Mic river course. The continuity of this bluff is broken only at Ponorel by Morii stream, which cuts a deep, roughly 1.5 km long valley through the crystalline schists in the northern part of the plateau.

The other boundaries of the plateau toward the Vidrişoara, Crişu Alb and Sohodol valleys display the same features, with steep slopes, yet with smaller absolute values of the elevation ranges.

Valea Morii, through its tributaries Dolea Mare and Zugău, divide the Poieni plateau in two parts, with different extensions: a western part, most of which is occupied by the Poieni internal drainage basin (12.4 km^2), and an eastern part, where the Sicoieşti - Dăieni depression (2.4 km^2) occurs.

Inside the basin, a series of concatenated ridges with elevations in excess of 1000 m, much alike to the bordering chain, delineate a series of sub-basins, sharply defined in terms of landforms shaping, among which we mention: the sub-basin Crucea cea Lungă (South of Struţu pick) - Hărăşti-Lacuri and Băii sub-basin.

The Sicoieşti - Dăieni depression mainly consists of a succession of large sinkholes, aligned along a NE-SW striking axis. It is completely devoid of surface stream courses, the local people water supply being restricted to a few dug wells and springs, located close to Sicoieşti hamlet, and a well dug in the north-eastern end of the depression, at Dăieni.

A specific feature of the shape of the slope that descends from the south-eastern border of the Sicoieşti - Dăieni depression toward the Sohodol stream is provided by a NE-SW striking row of small karst piracy depressions, positioned along the 800 m elevation contour. They are the Delimani, Napoieşti (Fig. 5.1, no. 24), Hoanca and Troaca Dealului (South-West of Peleş hamlet) and Zeheşti (Dolea Sohodoalelor, no. 20) depressions, the latter being however situated at a higher elevation. They all display perennial, complete, either diffuse or concentrated sinks.

Sohodol stream surrounds the limestone plateau to the south-east and east, collecting most part of its flow on non-karst terrains, situated to the south of the plateau. In its upper reaches (Valea Seacă) it has a temporary character, as a result of water sinking through the streambed alluvia, into the limestone substratum, the same water being further on discharged through the Feredeu spring (Fig. 5.1, no. 23), after about 3 km of underground flow.

The surface karst landforms (grikes, sinkholes, dry valleys, gorges) are frequent, while, alternatively, underground karst landforms are generally poorly developed. A few caves of small extension are known, Poieni pothole appearing, in terms of excavated spaces amplitude, as a particular occurrence in this area (150 m depth, D. TODA & B. BOSDOC, 1980).

5.3. The plateau hydrogeology

In the cracks and the karst dissolution voids of the crystalline limestones in Poieni Plateau important groundwater accumulations are stored, their impervious bedrock being provided by crystalline schists of the Muncel Nappe. In the southern part of the considered domain these groundwater accumulations are confined, their caprock being provided by the Senonian deposits of the Bucium Unit (the sedimentary cover of the Muncel Nappe) and of the Cretaceous ones of the Criş Nappe.

The recharge of the groundwater accumulations originates mainly in rainfall on crystalline limestone outcrops, the karst plateau being generally devoid of overlying deposits. An exception to this rule is recorded on the south-eastern border of the plateau, along the Răchita peak - Napoieşti lineament, where the Senonian, essentially sandstone deposits, store water accumulations that discharge through small flow rate springs of perennial character. In these springs originate stream courses which when reaching the crystalline limestone substratum, both to the north, in the Dolea Mare and Zugău catchment area, and to the south, in the Sohodol stream catchment area, totally or partially sink, to participate to the recharge of the karst water reservoir.

The absence of impervious intercalations in the crystalline limestone body suggests that a single karst aquifer exists, whose discharge occurs at its boundaries, being controlled by the systems of fractures and cracks that dissect the crystalline limestones body.

The water accumulations in Poieni Plateau discharge through a series of springs located at its boundary. The springs at the bottom of the northern slope, in the Arieşul Mic river catchment area, are lithologic contact springs, that discharge the unconfined groundwater accumulations at the boundary between the crystalline limestones and the underlying graphitic and sericitic schists. The main springs in this part of the plateau are: Morii spring (Fig. 5.1, no. 14), Lerţii (no. 2), Pişoaia Vidrii (no. 3), Zugău (no. 18) and "La Izvor" (no. 17). They exhibit, except for the last one, massive travertine deposits.

Over the hydrologic year October 1988 - September 1989, flow rate gauging stations have

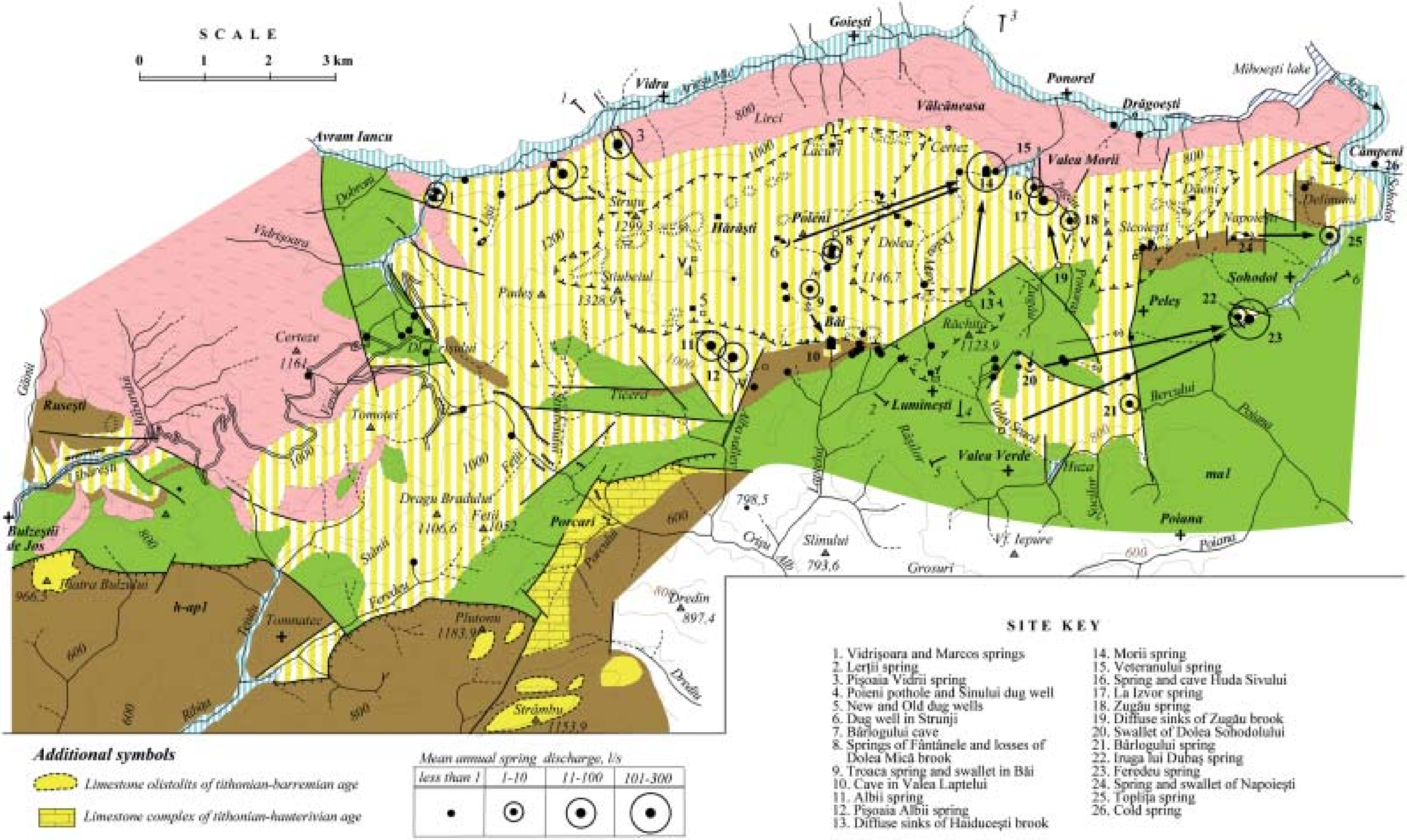

Figure 5.1. Hydrogeological map of Poieni Plateau
Geological data after R. PURECEL et al., 1966, 1968, C. BEJAN et al., 1985, S. BORDEA, R. CONSTANTINESCU, 1975. Legend as in Figure 1.6.

been installed at the main karst springs in Poieni Plateau, in order to establish their discharge regime. The considered hydrologic year exhibits, while taking into account the main rivers in the Apuseni Mountains, values that slightly exceed (102%, Figure 1.4) the multi-annual average. The previous year had exhibited a certain flow deficit (85.7%), and the following year exhibited the peak deficit (70.8%) over the entire 78/79-97/98 period (I. ORĂŞEANU, 2000). Tables 5.1 and 5.2 show the characteristic flow rates and the parameters derived from these springs flow rate recession, while Table 5.3 shows the results of the activable tracer tests, performed in cooperation with E. GAŞPAR, I. POP and T. TĂNASE, during the 1989-1990 period.

	Source	Qmed l/s	Qmin l/s	Qmax l/s	n_v	B_f	T (°C)	Corelation and spectral analysis		
								ME	TF	RT
1	Morii spring, Ponorel	229	63	1700	27.0	0.36	8.3 - 9.0	27	0.064	19
2	Feredeu spring, Sohodol	98	18	290	16.1	0.26	8.7 - 10.5	28	0.060	20
3	Lerţii spring, Avram Iancu	90	8	1605	200.6	0.13	6.8 - 8.8	4.5	0.016	8
4	Pişoaia Vidrii spring, Vidra	40	4	392	98.0	0.30	6.8 - 8.8	6.5	0.060	12

n_v, index of discharge variability; B_f, base flow index; T, water temperature; ME, memory effect; TF, truncation frequency; RT, regulation time.

Table 5.1. Characteristic discharges of the springs and results of the recession and of the corelation and spectral analysis.

Source	Morii spring	Pişoaia Vidrii spring	Lerţii spring	Feredeu spring	Huda lui Papară cave	Iezerului spring
Recession period	06.12.1988-20.02.1989	04.12.1988-20.02.1989	05.12.1988-19.02.1989	05.12.1988-19.02.1989	14.12.1989-24.01.1990	08.01.1989-03.03.1990
α, day $^{-1}$	0.0024	0.0227	0.0100	0.0100	0.0290	0.0255
η, day $^{-1}$	0.0400	0.0385	0.0400	0.0400	0.0769	0.0556
ε, day $^{-1}$	0.824	0.142	0.337	0.085	0.384	1.726
Q_0, l/s	415.0	115.0	150.0	180.0	600.0	54.0
Q_2, l/s	113.0	32.0	15.0	30.0	80.0	12.0
Q_{R0}, l/s	120.0	23.4	32.1	64.2	262.3	47.4
q0, l/s	295.0	91.6	117.9	115.8	337.0	6.6
t_i, days	25	26	25	25	13	18
Q'0, l/s	113.0	13.0	25.0	50.0	180.0	30.0
V dyn, m^3	4330000	89300	227000	554000	782000	161000
V' dyn, m^3	4070000	49600	216000	431000	537000	102000
v inf, m^3	69000	54000	43000	79000	87000	850
V0, m^3	4399000	143300	270000	633000	869000	161850
V dyn / V0, %	98.4	62.3	84.1	87.5	90.0	99.5
v inf/V0, %	1.6	37.7	15.9	12.5	10.0	0.5

α, depletion (recession) coefficient of the flooded zone; η and ε, parameters adopted for the falling discharge curves; Q_0, discharge for t=0; Q_2, discharge at the end of the recession period; Q'0, discharge at $t=t_i$; Vdyn, dinamic volume of the flooded zone, beginning with $t=t_o$, [Vdyn=C (Q_{R0} / α), where C is a constant equal to 86400 when discharge is expressed in m^3/sec and α in days^{-1}]; V'dyn, dinamic volume beginning with $t=t_i$, [V'dyn=C (Q'0 / α)]; v inf, volume evacuated from aquifer in falling period; V0, total volume, (V0=Vdyn+v inf).

Note: Huda lui Papară cave and Iezerului spring are situated in Trascău Mountains.

Table 5.2. Main parameters characterize the recession curve.

5.3.1. Izvorul Morii karst system

Izvorul Morii is located in the small Valea Morii depression, some 2 km south of Ponorel village, and it emerges from an outlet cave excavated at the bottom of the cliff under Colţul Sturului (P. CHIRILĂ et al., 1987). Over the roughly 50 m distance that separates the cave from the Dolea valley streambed, the spring flow runs across limestone boulders and, in its last section, past a series of small, stepwise positioned lakes, shaped in the travertine substratum.

The analysis of the recession curve recorded during the 1988-1989 winter (Table 5.2) indicates that the aquifer discharging through Izvorul Morii has important dynamic reserves, the contribution of the base flow being essential in building them (98.4%). The significant amount of the groundwater reserves is also substantiated by the very small value of the recession coefficient (α = 0.0024).

The activable tracer tests have indicated that Izvorul Morii discharges water sunk in the swallet at Fântana din Strunji (Figure 5.1, no. 6) and in the diffuse sinks of the Dolea Mică (Figure 5.1, no. 8) and Hoanca Haiduceşti valleys (Figure 5. 1, no. 13 and Figure 5.2).

5.3.2. Izbucul Lerţii karst system

Izbucul Lerţii discharges from a boulders accumulation situated at the bottom of an over 200 m high wall, under Struţu peak. A descending cave, partly plugged with crystalline limestone boulders, situated some 20 m upstream (B. BOSDOC, 1981), acts as an overflow during the high rainfall periods. In time, the spring has deposited a huge amount of travertines, that extends almost down to the Arieş river, the spring flow cutting its streambed, in its upper stream course, through its own deposits, that form a virtually horizontal flat ground.

The spring flow rate is highly fluctuating, the outlet displaying the highest variability index among all gauged springs in the Poieni Plateau (n_v = 200.6). It is also conspicuous because of its smallest base flow index value (B_f = 0.13, Table 5.3).

Labelling no.	Drainage no.	Insurgence	H, m	Resurgence	H, m	L, m	ΔH m	Tracer	T hours	Velocity (m/h)	Date of labelling
1	1	Napoieşti ponor	807	Topliţa spring	600	2450	207	In	288	8.5	09.05.1990
2	2	Fântâna din Strunji ponor	1095	Morii spring	700	6700	395	$BrNH_4$	264	25.4	26.06.1989
3	3	Losses of Dolea Mică brook	990	Morii spring	700	5000	290	$BrNH_4$	48	104.2	25.05.1990
4	4	Losses of Hoanca Haiduceşti brook	950	Morii spring	700	4500	250	KI	105	42.5	25.06.1989
5	5	Losses of Valea Seacă brook	750	Feredeu spring	600	8500	150	In	432	19.7	24.06.1989
6	6	Zeheşti ponor	940	Feredeu spring	600	6850	340	In	216	31.7	24.05.1990
	7	"	"	Iruga lui Dubaş spring	610	6550	330	"	408	16.1	"
7	8	Losses of Haiduceşti brook	920	"La Izvor" spring	670	2350	250	NaI	48	50.0	24.05.1990
8	9	Losses of Troaca Băii brook	1010	Spring of Laptelui brook	800	1900	210	In	96	17.7	25.06.1989

L, horizontal distance between insurgence and resurgence; ΔH, difference in level between insurgence and resurgence; T, time of first arrival of tracer; V, apparent velocity.

Table 5.3. Results of tracing operations in the Poieni Plateau.

5.3.3. Pişoaia Vidrii karst system

Pişoaia Vidrii spring is the third important outlet on the northern slope of Poieni Plateau. It is located some 1 km downstream with respect to Izbucul Lerţii, with its water emerging from a limestone boulders accumulation. A cave situated above the spring, descending down to -5 m and extending over 38 m length, acts as an overflow to the karst system (B. BOSDOC, 1981). The massive travertine deposits have built a horizontal platform, from which the spring flow jumps over some 15 m, to form a spectacular waterfall.

By processing the flow rates series recorded during the recession period of the 1988-1989 winter, a low groundwater reserves value was derived, together with a significant weight of the fast flow in building these reserves (37.7%, Table 5.2).

5.3.4. "La Izvor" karst system

"La Izvor" karst outlet is located on the left side of Zugău stream, some 100 m upstream with respect to the last house of Valea Morii hamlet. It emerges at the bottom of a crystalline limestones wall, from a boulders accumulation, at 670 m elevation. During the October 1988 - September 1989 hydrologic year, the spring flow rate fluctuated between 10.8 and 123.4 l/s, with a 21.8 l/s average flow rate value. During the period May 1991 - December 1992, the average gauged flow rate has been 8 l/s, while the water temperature fluctuated between 7.6 and 8.8°C.

The springs collects its water from Zugău stream upper catchment area, a fact which was proven by a KI activable tracer test performed in the diffuse sink of Haiduceşti stream, a tributary of Zugău stream.

5.3.5. Feredeu karst system

The occurrence of Feredeu spring (Figure 5.1, no. 23) is related to a small tectonic window, that allows crystalline limestones to outcrop in the middle of the Cretaceous sandstone-carbonate flysch body. The spring is situated on the right side of Sohodol stream, some 1 km upstream from the center of the homonymous village. Upstream with respect to the karst spring, in its close proximity, from the gravel and sand of an alluvial fan, diffusely emerges a spring discharging 0,1-2 l/s together with gas outflows.

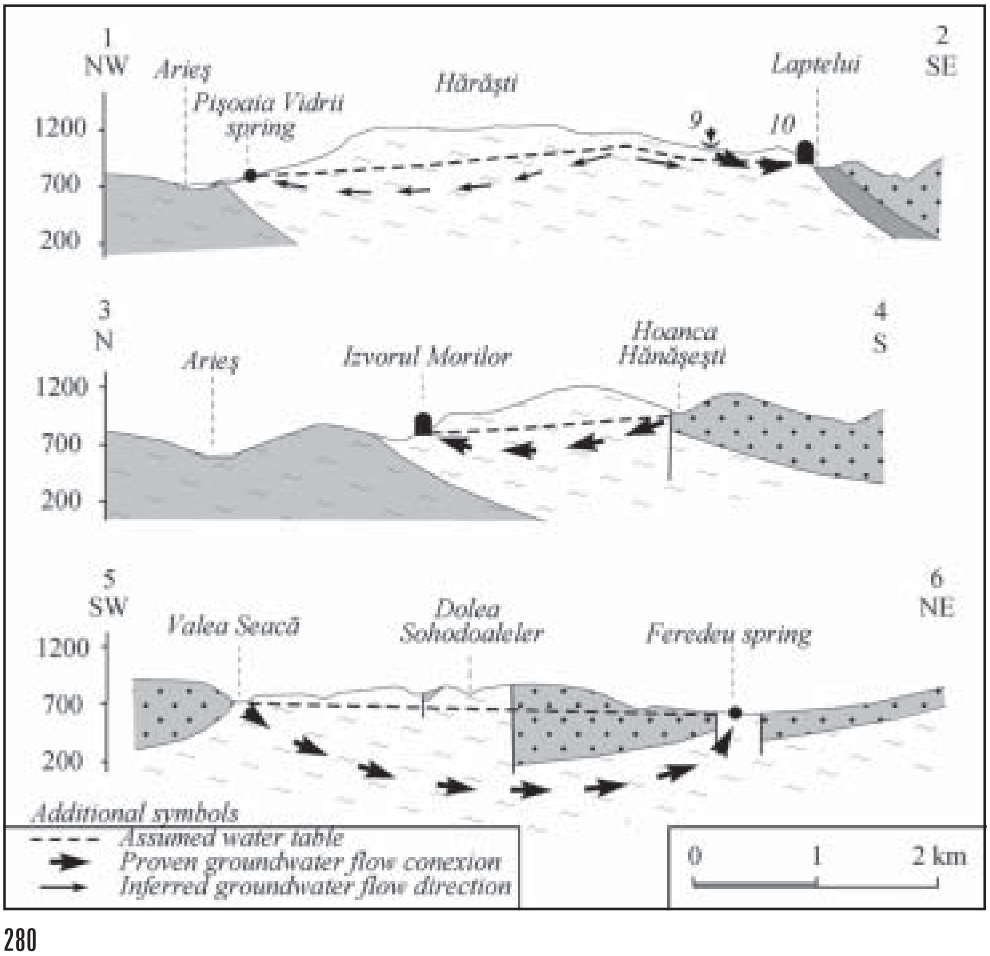

Figure 5.2. Hydrogeological cross sections in the Poini Plateau. (Legend as in Figure 1.6. Line of section shown in Figure 5.1)

The karst spring system extends in the south-eastern part of Poieni Plateau, discharging in a perennial way, and temporarily in a complete way, the stream course of Valea Seacă (Figure 5. 2).

The karst system has relatively important reserves, and its recharge from surface streams is mirrored also by the relatively large weight that the fast flow occupies in the water volumes that the system discharges (12.5%).

5.3.6. Other outlets

- The springs at Morcoş (Fig. 5.1, no. 1), emerge from the right side of Vidrişoara stream, at the bottom of a small limestone escarpment, some 500 m upstream the junction with Arieşu Mic river. They are situated some 40 m apart from one another and have an average cumulated flow rate of 10 l/s. The temperature of the spring located downstream fluctuates between 7.7 and 9.5°C, while the one located upstream exhibits larger fluctuations, 5.3-11°C, probably as a result of water inflows originating in the Vidrişoara stream alluvia.
- Zugău spring (no. 18). Downstream with respect to the Haiduceşti and Ponoraş streams junction, over a distance of about 1 km, Zugău stream flows down a gorge section strewn with waterfalls and cauldron pots, that deny access even to the most resolute pedestrian, local people using, in order to avoid this area, a footpath which reaches high up the right side of the stream.
  At the gorge exit, on the left side, a water spout that locals call Zugău spring gushes out from a crack enlarged by water corrosion. The average flow rate is 11.7 l/s, fluctuations ranging between 5.7 - 6 6.0 l/s. The travertine deposits (that locals call "galiţa") make the outlet area conspicuous in the topography.
- Iruga lui Dubaş spring (no. 22), is located on the left side of Sohodol stream, opposite to Feredeu spring. It emerges from a crack in crystalline limestones, with a flow rate ranging between 1 and 10 l/s. It is not tapped.
- Topliţa spring (no. 25) is the easternmost outlet in Poieni Plateau. It is located opposite to the Sohodol quarry and it emerges from crystalline limestones. The spring is tapped in a concrete pool. The spring flow rate fluctuates over the 1.5-30.0 l/s range, displaying an average value of about 10 l/s. The measured temperatures fluctuated between 8.8 and 9.9°C over the investigation period. Worth mentioning are massive travertine deposits. The spring discharges the water accumulations at the easternmost end of the plateau, mainly those in the Napoieşti area.
- Bârlogului spring (no. 21), is located in the south-eastern part of Poieni Plateau, in Berbecului stream catchment area. It emerges in a typical blind valley, from a limestone boulders accumulation, at the bottom of a ca. 15 m high escarpment. The outlet minimum flow rate is 2 l/s, while the average flow rate amounts to 12 l/s. The spring exhibits no travertine deposits.
- The spring in Valea Laptelui (no. 10), discharges 3 l/s from a cave entrance (speleological code 3100/36), excavated in a ca. 70° steep mountain slope. At the bottom of the cave there is a 10 m high waterfall, with no travertine deposits.
- Albii spring (no. 11), emerges through a rift that is widely opened by water flow, and can be entered over at least 4 m, located at the bottom of Coasta Albii, a vertical wall of strongly cracked and corroded crystalline limestones. 10 m downstream with respect to the spring, over a distance of at least 50 m, there occur massive travertine deposits, with the spring flow running around their right side, to form a series of waterfalls. Upstream with respect to the spring, Valea Albii displays a temporary flow regime and is marked by many fossil cauldron pots. The outlet minimum flow rate is about 15 l/s, its average value reaching about 55 l/s.
- Pişoaia Albii spring (no. 12) emerges from a dissolution conduit (70 × 30 cm) located at the bottom of a 7 m high crystalline limestones cliff. After crossing for some 40 m a virtually horizontal, grass-covered flat, the water falls down a 15-20 m high waterfall toward Valea Alba. The outstandingly scenic flat and waterfall are made of travertines, deposited by the spring flow. Local people claim that the spring never discharges muddy water. The minimum spring flow rate is 20 l/s, and the average one is 60 l/s.

- The springs in the Crişul Alb streambed. In the Crişul Alb upper reaches, in the section where it crosses the crystalline limestones of Poieni Plateau, diffuse groundwater inflows occur through the streambed alluvia. Expeditionary flow rate gauging outlined minimum groundwater inflows of 110 l/s and average inflows estimated to 200 l/s. The inflows occur along the river section that extends between the elevations 680-570 m, in the area of its junction with the stream that has its headwaters beneath Ştiubeiul peak.

The primary chemical characteristic of the water discharged by the main springs in Poieni Plateau (Ca-HCO_3 type) is over-saturation with respect to calcite, resulting in abundant precipitation of this mineral immediately downstream with respect to the springs, as a result of the release of CO_2 from solution. The positive values of the calcite saturation indexes, computed for the water of the springs Mori, Pişoaia Vidrii and Lerţii, confirm this fact (Table 5.4)

The water of the Zugău spring have elevated concentrations of Na, probably as a result of domestic sewage pollution from the villages in upstream course.

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Spring name	Date	T (°C)	ph	Cl^-	SO_4^-	HCO_3^-	Na^+	K^+	Ca^{++}	Fe^{++}	Mg^{++}	TDS	S.I.	
				ppm									calcit	aragonit
Izvorul Morii	X.88	8.7		7.1	7.7	219.6	1.2	1.1	80.2	0.1	sld	386.7		
Izvorul Morii	VIII.96	8.2	7.64	7.1	17.2	231.8	1.5	sld	84.4	sld	1.0	415.3	0.239	0.084
Izvorul Morii	IV.00	8.8	8.45	5.7	0	225.7	0.8	0.6	76.2	0.2	0	338.5	0.938	0.782
Lerţii	X. 88	7.7		7.1	9.0	146.7	21.0	1.9	41.3	0.1	0.7	258.8		
Lerţii	VIII.96	7.8	7.90	7.1	15.4	256.2	0.6	sld	94.8	sld	sld	441.0	0.535	0.377
Pişoaia Vidrii	VIII.96	8.1	7.38	7.1	17.3	256.2	1.5	sld	92.9	sld	1.0	449.4	0.029	-0.128
La Izvor	X.88			7.1	17.3	244.0	38.0	1.0	57.7	sld	sld	376.2		
Zugău	X.88			28.3	36.4	341.6	67.5	1.0	84.1	sld	sld	571.5		
Feredeu	X.88	11.8		7.1	9.0	198.2	21.6	2.4	48.1	0.1	1.2	307.3		
Iruga lui Dubaş	X.88			10.6	9.0	256.2	23.5	2.3	66.5	0.1	2.4	395.0		
Pişoaia Albii	VI.89			7.1	8.9	146.4	4.1	sld	52.1	0.1	sld	231.7		
Izvorul Albii	VI.89			7.1	16.4	158.6	3.5	1.8	56.9	0.1	sld	253.9		
Ţiganilor	X.88	8.5		7.1	23.0	97.6	28.4	1.1	20.0	0.5		200.8		
Spring of Băi	VI.89			7.1	8.9	146.4	4.2		43.3	0.1	5.4	228.4		
Fântânele	V.90			7.1	28.8	134.2	13.3	0.4	48.1	0.3		232.2		
Well of Hărăşti	V.90			7.1	20.2	256.2	5.8	11.0	50.1	0.1	21.6	372.1		

Table 5.4. Major ions and saturation indexes of water sources in Poieni Plateau.

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