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STUDIU PRELIMINAR ASUPRA APELOR FREATICE DE LA CONFLUENȚA RÂURILOR CERNA ȘI OLTEȚ, PIEMONTUL GETIC (ROMÂNIA)

PRELIMINARY STUDY OF THE PHREATIC WATERS AT THE CONFLUENCE OF CERNA AND OLTEȚ RIVERS, GETIC PIEDMONT (ROMANIA)

Constantin ENACHE[1], Oana MITITELU-IONUȘ[2]

Abstract: In the Olteț floodplain, the alluvium contains a small-thickness aquifer phreatic, consisting of small pebbles and sands remodelled from the deposits brought by the upstream river; these are store rock suitable for significant groundwater accumulation. The research used hydrogeological data made available by the Olt Water Administration (12 observation wells) and its own measurements made between October 2017-May 2018. The observation drillings, taken into account, are located on a West-East alignment, located after the confluence of the Cerna River with the Olteț River within the area of Bălcești-Băbeni-Otetelișu localities. At the Cerna-Oltet confluence, the hydrostatic level of the groundwater aquifer is at depths between 187.43 cm - F1 Oteteliș and 179.44 cm - F3 Bălcești (average multiannual for the period 2007-2016). The analysis of the lithological columns and the measurements of the hydrostatic levels in the observation wells led to the highlighting of the location of the drilling on hydrogeological sections and to the drawing of the variation of the hydrostatic levels of the hydro-hips map. The results obtained from the measurements on the hydrostatic level from 3 wells located in the study area between October 2017-May 2018 were corroborated with the specialized literature, more exactly hydrological and climatic research. Consequently, the present study confirms and explains the contribution of groundwater from the meadow to the flow of the Olteț and Cerna Rivers in the confluence sector.

Key-words: *phreatic aquifer, drilling, hydrostatic level, meadow, Cerna-Olteț confluence*
Cuvinte-cheie: *acvifer freatic, foraj, nivel hidrostatic, luncă, confluența Cerna-Olteț*

I. INTRODUCTION

Within the Olteț Piedmont (division of the Getic Piedmont) the process of hydrographic network formation and its evolution resulted in the deeper sectioning of the Pliocene-Quaternary sedimentary cover. The basic level in continuous descent during the Quaternary and the active tectonics, which subjected the

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northern extremity to an accentuated rise, were the factors according to which the entire hydrographic network deepened (Aur, 1996). The Piedmont sector of the Olteț Valley is located between its confluence with the Târîia stream in the north and the hydrographic convergence area in Balș in the south. The length of the river between these limits is 96 km. The morphometric and morphographic characteristics of the valley remain almost unchanged until the Olteț River enters the Otetelișu syncline, where the confluence with its most important tributary, the Cerna River (78.2 km wide) (*Atlas of the Romanian Water Cadastre, 1992*). Near the confluence with the Olteț River, the Cerna Valley has the largest extension, up to 4 km (Aur, 1996). At the Cerna-Olteț confluence, the highest altitudes are in the northeast and reach 300 meters at the Răii Hill, and the smallest are in the southeast of the locality, in the meadow created by the convergence of Olteț River with its tributaries (Pesceana and Cerna), having landscapes characteristic of the intercolateral plain. In this southern sector, the altitudes are around 130-190 meters, the waters are shallow white, they are meandering due to the small slope, and their drainage direction is slightly oriented south, south-east, towards the withdrawal of the waters of the Quaternary Lake (Aur, 1996).

In the Olteț floodplain, alluviums contain a small, 2–4 m thick phreatic aquiferous horizon, consisting of small gravels and sands remodeled from the deposits brought upstream, these are store rocks suitable for important groundwater accumulations (Cinetti, 1990).

The transmissivity of the groundwater horizon varies between 0.3 - 1.0 $l/s/m^2$, the filtration coefficient being between 10 - 20 m/day (Enache, 2008). This aquifer with natural character and typology RO08, has a monitoring section at Oteteliș (*The Management Plan of the Olt river basin, 2016-2022*). The general flow direction is from north to south. The importance of this aquifer is local, being used by the inhabitants of the villages in the area bordering the city of Bălcești, in the household and in the watering of the gardens.

II. DATA AND METHODS

Besides the specialized literature in the elaboration of the study were used hydrogeological data made available by the Olt Water Basin Administration – Olt WBA (12 observation wells - Bălcești and Otetelișu) and own measurements made between October 2017-May 2018 (3 fountains located in the Bălcești and Otetelișu localities). For the analysis of the groundwater and its interaction with the surface waters, respectively the Olteț and Cerna Rivers, in the confluence sector, we compared increase of the phreatic hidrostatic level in the observationdrilling with the increase of the Olteț flow rates at the Oteteliș hydrometric station.

III. RESULTS AND DISCUSSIONS

The water supply of the groundwater aquifer layer from the Olteț meadow, at the Cerna-Olteț confluence, is made from atmospheric precipitation, from the waters of the springs present at the base of the terraces from deep aquifers with

which the meadow comes into contact and occasionally from the Olteț River (Andreescu et al., 1985).

In order to verify the potential of this layer from the Oltețului meadow (the area between the localities Bălcești, Oteteliș, Băbeni, Olteț, Pietroasa and Râureni), the observation wells of the Olt Water Basin Administration were taken into consideration for the groundwater aquifer horizon, named F1, F3, F4, F5, F1A (Bălcești) and F1, F2, F3, F4, F5, F5A, F6 (Oteteliș) (*Olt Water Basin Administration, Slatina Water Management System*). The absolute share of the land at the respective drilling and the average share of the static level of the groundwater aquifer in the meadow (established as the average of the measurements made during 10 years, 2007-2016) are presented in Table no. 1.

Table no. 1 Drilling land share and hydrostatic level share of at the observation wells from the confluence of the Cerna-Olteț Rivers

No.	Settlement	Location	Drilling land share (m)	Share of multiannual average of hydrostatic level (m)
F1	Bălcești	Terrace	193.84	-
F1A	Bălcești	Meadow	184.15	183.88
F3	Bălcești	Meadow	179.68	179.44
F4	Bălcești	Meadow	183.97	183.74
F5	Bălcești	Terrace	207.64	-
F1	Oteteliș	Terrace	187.62	187.43
F2	Oteteliș	Meadow	184.42	184.38
F3	Oteteliș	Meadow	184.86	184.38
F4	Oteteliș	Terrace	193.60	-
F5	Oteteliș	Terrace	186.17	-
F5A	Oteteliș	Terrace	186.26	-
F6	Oteteliș	Terrace	192.47	-

(Source data: Slatina Water Management System, 2007-2016)

The location of the drilling and the hydrostatic level share indicate the inclination of the surface of the level of the groundwater horizon to the Olteț and Cerna Rivers, respectively the rivers feeding within the Bălcești sector from the phreatic aquifer horizon (Fig. 1).

In the three sections drawn up (Fig. 2,3,4), the position of the alluvia from the Olteț meadow in the area of confluence with its tributary Cerna was outlined. At the same time, these sections indicate the feeding of the groundwater aquifer from the deep-water layer of aquifers with which the alluvium comes into contact. Starting from the values of the hydrostatic level situated in the meadow and mentioned in the table bellow, the map with the extension of the meadow and the water-horizons of the phreaticr aquifer was drawn up (Fig. 5).

The section A-B made between Oteteliș and Bălcești localities, on the right side of the Olteț River, indicates intense waterfalls in the meadow with deep water from the aquifers of the Romanian deposits that make contact with the terraces and the meadow.

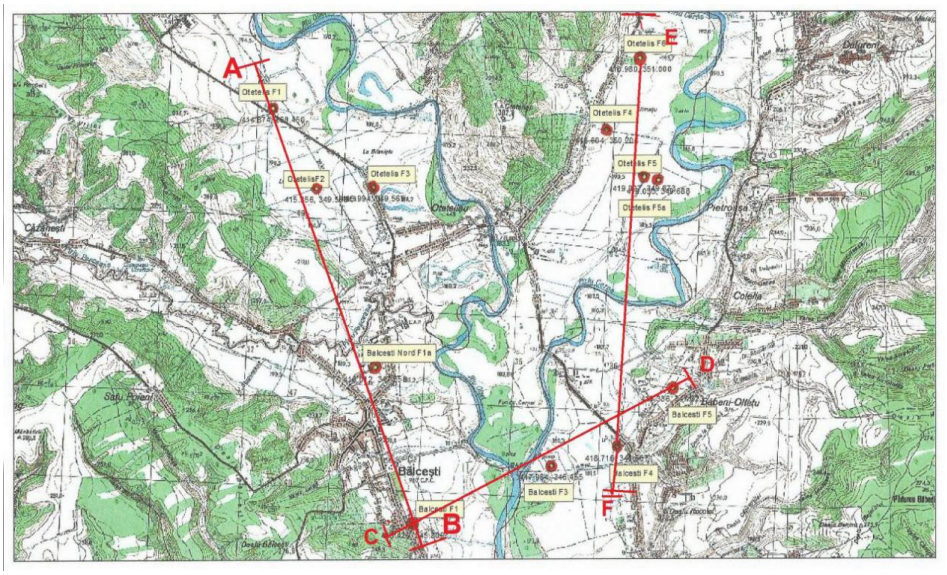

Fig. 1. Location of the considered hydrogeological sections
(Processing according to Olt WBA drilling location and 1: 50,000 topographic map)

The section C-D crosses the Olteț River at the confluence with the Cerna River and also highlights that the meadow intersects the Romanian aquifer layers, thus feeding the water from both sides of the meadow.

The E-F section along the Cerna River, a tributary to the left of the Olteț River, starts from the right of Cerna River and ends on the left of the same aquatic organism, at Băbeni-Oltețu settlement. In this section it is emphasized that, in the Bălcești sector and the Cerna meadow, they intersect the Romanian aquifer layers.

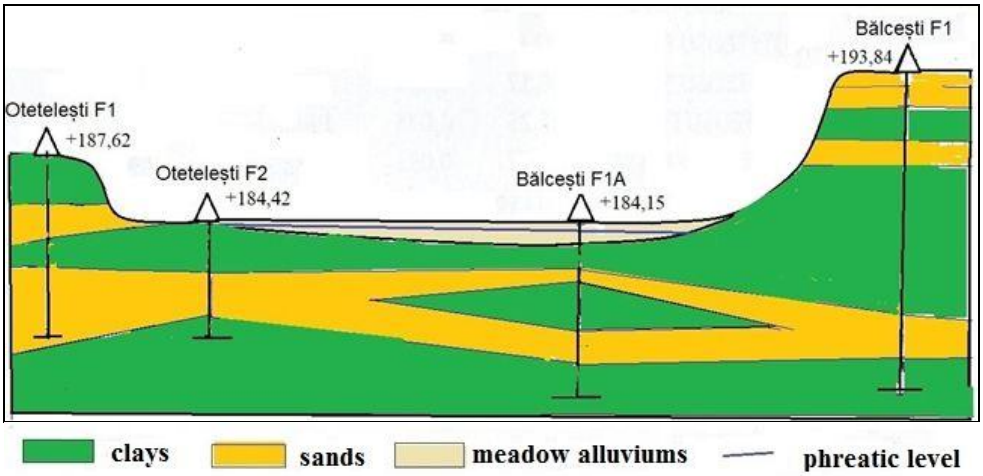

Fig. 2. Section A-B

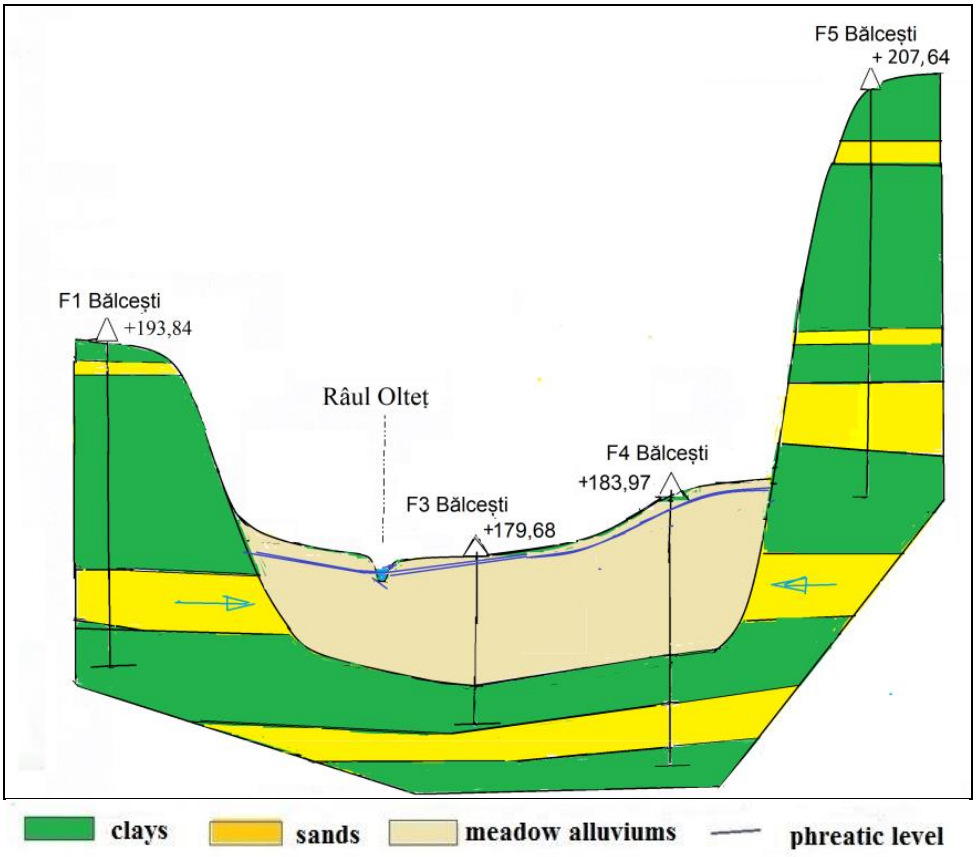

Fig. 3. Section C-D

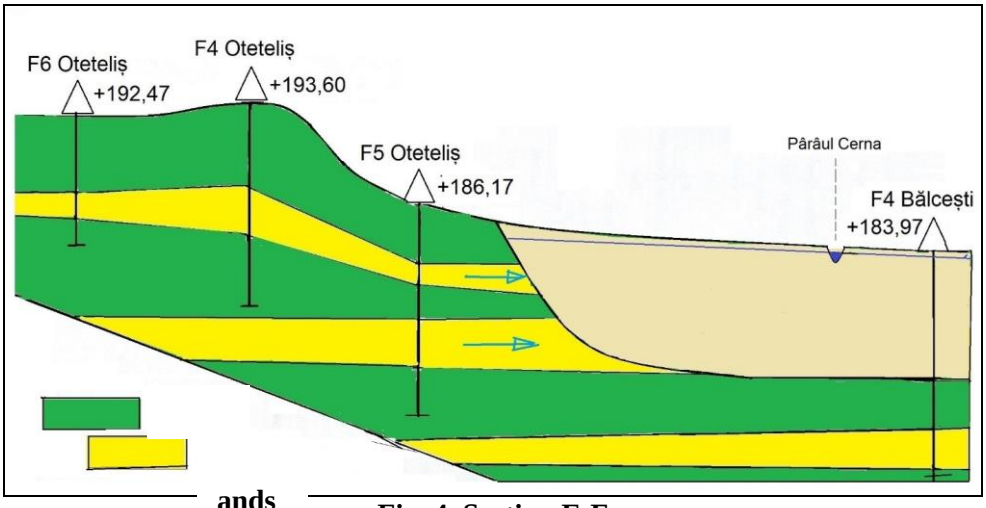

Fig. 4. Section E-F

In turn, the groundwater from the Olteț and Cerna meadows, feeds these watercourses from the Bălcești sector, as it also results from the map with the hydro-hips (Fig. 5).

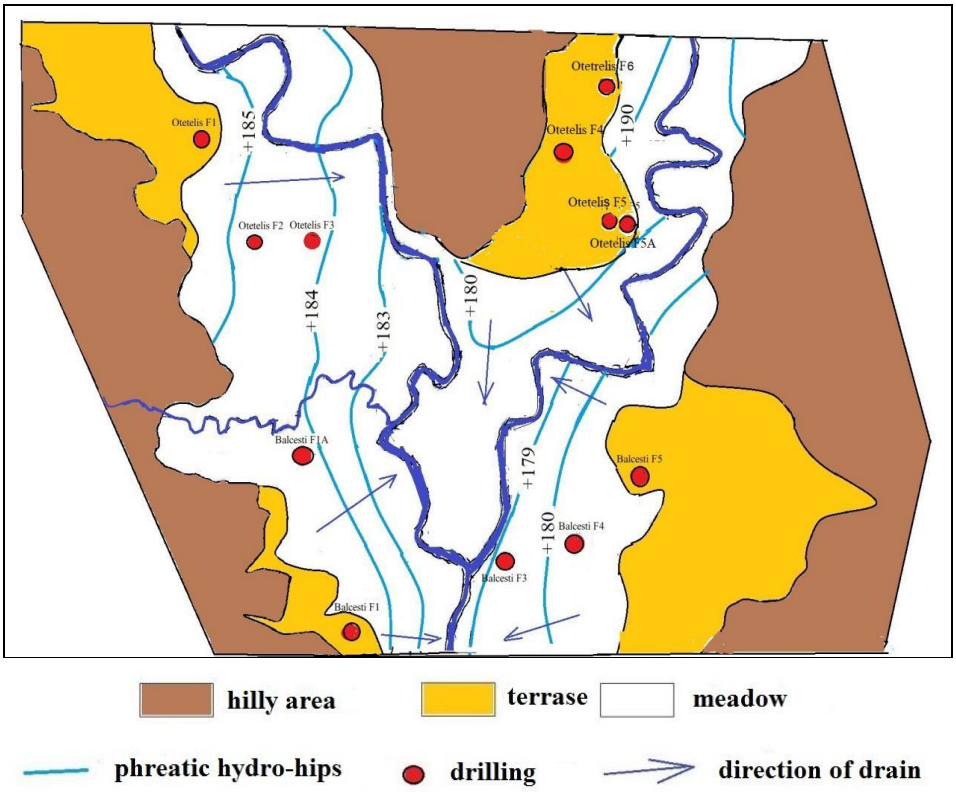

Fig. 5. The hydro-hips map at the confluence of Cerna - Olteț (Bălcești-Oteteliș u localities)

Taking the balance of the Olteț River flow at the Oteteliș hydrometric station, Savin (2008) concludes that on average, 34.5% of its total supply comes from groundwater (Table 2). The percentage values of the Olteț River's flow sources are quite close, more precisely after the underground feeding, followed by the pluvial feeding - 34% and the feeding from the snow melting 31.5%.

Table no. 2 The contribution of the sources to the formation of the Olteț River flow at the Oteteliș hydrometric station, in the 1950-2004 period

Source	%
Groundwater	34.5
Snow melting	31.5
Rainfall	34.0

(Source data: Savin, 2008)

The maximum flow - Q max of Olteț River was recorded in May 1967, being almost 10 times higher than the average flow Q0 (modular value, calculated over 50 years) (Tab. 3). This situation is also supported by the monthly distribution of the average flow at the Oteteliș hydrometric station, which also indicates a maximum in May - 15.25% (Tab. 4). In fact, in this sector on the Olteț River, the highest flow is recorded in spring with a percentage value of 41%. The smallest monthly flow is recorded in the autumn, the percentage value being only 12.1%.

Table no. 3 Maximum flow and average flow at the Oteteliș hydrometric station from 1950-2004

Q_0 (m^3/s)	Q_{max} (m^3/s)	Month	Year	Period of observations
5,26	50,70	V	1957	1950-2004

(Source data: Savin, 2008)

Table no. 4. Monthly flow - % of annual flowe at Oteleliș hydrometric station from 1950-2004

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
7.47	10.42	12.50	13.25	15.25	11.80	6.33	4.63	3.16	3.39	5.55	6.89

(Source data: Savin, 2008)

The values mentioned above are supported by research on the variation of precipitation in the Getic Piedmont, the specialized literature shows the decrease of precipitation quantities for the summer and autumn seasons (Dragotă et al., 2009; Marinică and Marinică, 2018). At the same time, the Piedmont area of Oltenia Region, where the land is largely used agriculturally, was highlighted by the most obvious decrease of the quantities of precipitation recorded in the spring (Vlăduț and Onțel, 2014). Thus, the hypothesis of feeding the Olteț River from the groundwater is confirmed in May.

For a better understanding of the groundwater from the Cerna-Olteț confluence, own measurements were made between October 2017 - May 2018 on the hydrostatic level of the public and individual drilling, considered as case studies (located in Bălcești and Otetelișu) (Tab.5).

The level measurements in two fountains in Oteteliș and one in Bălcești (Tab. 5), indicate the highest level of groundwater also in May (215 cm, Ft. 1 Otetelișu; 330 cm, Ft. 2 Otetelișu; 449 cm, Bălcești), where it follows that the hydrostatic level considerably influences the high flow of Olteț River. This phreatic aquifer is also influenced by the pluvial regime (decrease of precipitation amounts) in the autumn season, when the highest values of hydrostatic depth are recorded (368 cm, Ft. 1 Otetelișu; 396 cm, Ft. 2 Oteteliși; 538 cm, Bălcești) (Fig. 6,7,8). The largest difference in depth of the hydrostatic level from the investigated fountains is recorded in the locality Otetelișu (Ft.1, 153 cm), fact due to the location between the two watercourses, the area in which the direction of the groundwater flow is net from the north to the south, from Otetelișu hill (302.8 m) to the Cerna-Olteț confluence (176 m).

Table no. 5. Variation of the hydrostatic level in investigated the wells from the localities of Bălcești and Otetelișu

Date / No. and locality	06.10 2017	13.10 2017	20.10. 2017	17.10 2017	03.12 2017	09.12 2017	15.1. 2017	21.12 2017	03.03 2018	09.03 2018	15.04 2018	01.05 2018
	(cm)											
Ft. 1 Otetelișu	355	355	368	350	230	240	260	255	255	217	225	215
Ft. 2 Otetelișu	396	396	396	390	380	360	370	365	350	345	340	330
Ft.3 Bălcești	520	522	538	529	517	513	514	511	502	498	493	449

(personal measurements from October 2017 to May 2018)

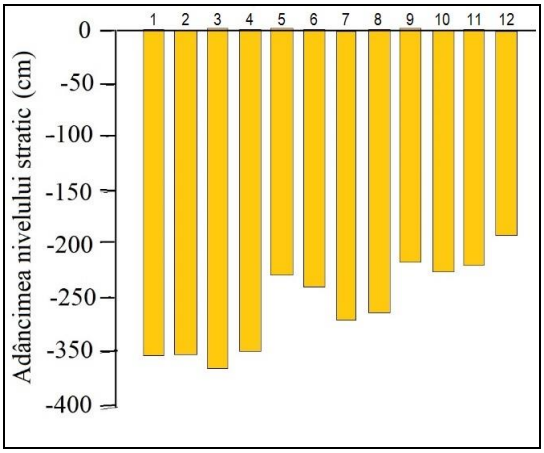

Fig. 6. The hydrostatic level of the groundwater in the fountain Ft 1. Otetelișu

From a qualitative point of view, the groundwater body ROOT08 was considered at risk for the NH4 and NO3 indicators. Considering that the drilling with overpass represent about 42% of the observation points and are evenly distributed on the monitored surface, this body of water is considered to have poor quality status for the NO3 and NH4 indicators (Bretotean et al., 2006). According to Olt WBA, in 2015 the quality of groundwater from the ROOT08 groundwater body (The lower Olt River meadow and terraces) was followed by 59 observation points (drilling). Of these, there were exceedances of the threshold values in the indicators NO3, NH4, Cl, PO4 and Pb. Also in 2015, through a study carried out by Romanian Research Institute for Environmental Engineering, the presence of trichlorethylene and tetrachlorethylene in F3 Bălceşti drilling was highlighted, the presence of these substances is due to the anthropogenic impact.

Much more precise on the study area, in the Management Plan of the Olt River Basin (2016-2022), from the point of view of the risk of not achieving the good quantitative status, it is specified that in the administrative territory of Bălcești, all water bodies are classified as not at risk.

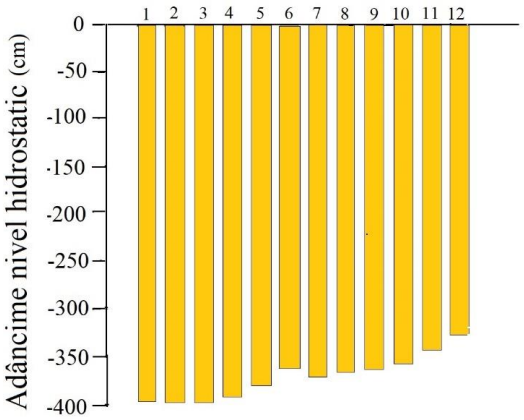

Fig. 7. The hydrostatic level of the groundwater in the fountain Ft 2. Otetelișu

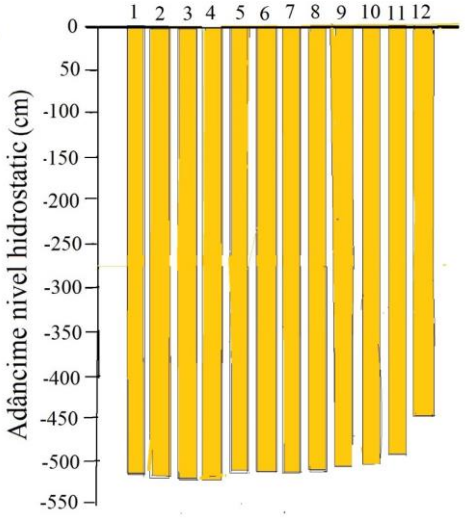

Fig. 8. The hydrostatic level of the groundwater in the fountain Ft 3 Bălcești

IV. CONCLUSIONS

The results presented above, argue that at the confluence of Cerna-Olteț Rivers, a quite important contribution of the Olteț flow comes from the phreatic aquifer existing in the rivers meadow. The hydro-hips maps, based on the results of the investigated drilling, confirms the natural flow direction of the groundwater aquifer to the river it feeds. From the existing data it results that at the Oteteliș

hydrometric station the maximum multiannual flow of Olteț River is reached in May which corresponds to the maximum rainfall and the maximum increase of the groundwater level in the analyzed surveys.

The importance of the research consists in the outline of a complex image on the groundwater in the perimeter of the Bălcești locality. The results obtained are useful both the locals who use the water from the wells to irrigate the individual gardens, as well as the local and regional institutions responsible for the water supply system in particular (Balcești city, Otetelișu and Gorunești villages) and with the management of water resources in general.

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LITHOLOGICAL CHARACTERISTICS AND STRUCTURAL IMPLICATIONS FOR THE RELIEF WITHIN THE GILORT BASIN (ROMANIA)

CARACTERISTICI LITOLOGICE ȘI IMPLICAȚII STRUCTURALE ÎN ASPECTUL RELIEFULUI DIN BAZINUL GILORT

Emil MARINESCU[1]

Abstract: The study highlights the structural and lithological implications within the three morphological sectors of the Gilort hydrographic basin. Within the mountaineous sector, there are mostly obsecvent glacial cirques, since this versant, although developed on the southern flank of the main ridge anticline, descends northwards, towards the glacial cirques Groapa Mândrei-Mohoru, situated southwards of the main ridge. The obsecvent character of the cirques causes a steep aspect of the slopes and the emergence of some shelf counter-slope. Within the Subcarpathians sector, most of the landslides occur on the strata end of cuestas or subsequent at the upper parts of the torrential valleys. The typical example of landslides along the cuestas can be found along the Giovria valley, where there are also some forms of slope undercutting due to torrential erosion within Pliocene deposits, alternating with marls, clays and sands, gathered in a folded and faulted structure (Câlnic anticline). Within the piedmont sector, the slopes of the valleys that cut through the Jiu Hills are heavily affected by present modelling process, and the river beds are drown in alluvia. On the left slope of the Gilort river basin, the neotectonic movements and modelling agents dug out strips of Romanian deposits. The predominantly clayish facies of these formations has caused recent landslides on the deforested slopes from the Vladimir basin, while the relief on Pleistocene sands and gravels is affected by ravines (the left slope) and landfalls with large steep slopes (right slope).

Key-words: *petrographic and structural relief, cuestas, present geomorphological processes, the Gilort*
Cuvinte-cheie: *relief petrografic și structural, cueste, procese geomorfologice actuale, Gilort*

I. INTRODUCTION

The Gilort hydrographic basin covers an area of 1358 sqkm, the river flowing generally from north to south on 116 km, with a hight difference of 2412 m (from 2518 m to 106 m). The area that is drained by the river overlaps three major morpho-structural units, distinct from the genetic, evolution, morphological, morphometric and bio-climatic point of view. Thus, almost a quarter of the basin overlaps the mountain sector, 38% the Subcarpathians and the remaining 37% the piedmont sector (Fig. 1). These are, from north to south,

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the Parâng Mountains (its southern slopes), the Gorj Subcarpathians and the Getic Piedmont (the Jiu Hills and Olteț Piedmont).

Table no. 1. Geographical location and share of relief units within the Gilort hydrographic basin

Basin sector	Coordinates				Area	Share of the basin area
	S	N	V	E		
Montain	$45^{0}10'$	$45^{0}21'12''$	$23^{0}28'15''$	$23^{0}46'15''$	342 sqkm	25 %
Subcarpathian	$44^{0}54'$	$45^{0}10'$	$23^{0}24'52''$	$23^{0}47'04''$	512 sqkm	38 %
Piedmont	$44^{0}35'36''$	$44^{0}54'$	$23^{0}20'13''$	$23^{0}36'17''$	504 sqkm	37 %
Total basin	**$44^{0}35'36''$**	**$45^{0}21'12''$**	**$23^{0}20'13''$**	**$23^{0}47'04''$**	**1358 sqkm**	**100 %**

The mountainous unit covers an area of 342 sqkm from the Parâng Mountains, where several sectors with distinct traits can be found:

The sector of high mountains, with glacial and periglacial relief developed on the Danubian Authochtonus, where granitoid intrusions prevail. At the Gilort springs, there are nine glacial cirques, most of them obsecvent ones, located around some short glacial valleys. The morphology of these valleys if characterised by the appearance of some thresholds, steps, digging depressions, debris cones, nival and fluvial streams, gorge mini-sectors. Within the Gilort basin, the cirques are frequently situated at 2000 – 2100 altitude and only exceptionally can be found at 1900 m (Marinescu, 2007). Within this sector, the altitudes above 1750 m prevail, while 16 peaks from the main ridge exceed 2000 m.

The sector of high mountains, where Borăscu complex is well preserved and is best developed. It can be found especially in the north-eastern part of the basin, around Iezer, Dengheru, Păpușa, Cioara, Galbenu, Mușetoaia peaks, some of them looking like some pyramids, while others are rather round tops, peaking over almost horizontal surfaces, at the upper level of interfluves, and displayed in two steps: Borăscu I (2000–2100 m) and Borăscu II (1750–1900 m).

The sector of middle high mountains, characterised by the longes interfluves in Parâng, sometimes reaching 10 km long. These interfluves preserve the largest Râu-Șes levelling surface, with two steps: 1500–1650 and 1400 m.

The Subcarpahtian unit covers 512 sqkm (38%) and belongs to the Gorj Subcarpathians. The relief is made up of depressions and longitudinal hills, almost parallel to the southern flank of the Parâng massif. As morphological traits, we mention the succession of depression couloirs (Oltenia Subcarpathians Depression, Câmpu Mare Depression) and Subcarpathians hills,