THE INVENTORY AND HIERARCHY OF GEOMORPHOSITES IN THE VLĂDEASA MASSIF

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The inventory and hierarchy of geomorphosites in the Vlădeasa Massif. At first glance, the Vlădeasa Massif does not stand out in the Apuseni Mountains in terms of the number of geomorphosites it contains, nor in terms of their diversity. But, if one carefully analyzes the landforms in this area, one would find a surprising number of landmarks that could be classified as geomorphosites. Karstic landforms are the most numerous among these, surprisingly one may add, for a massif that is mainly build up by volcanic rocks and crystalline schists. The karst geomorphosites are all situated in the limestone area of the massif, the Stanciului Valley. After a diagnosis performed on these potential geomorphosites, using the method already successfully applied for the Trascău Mountains, the list of geomorphosites in the Vlădeasa Massif, containing 20 such sites was generated. Most of them are endokarstic forms: caves, potholes and swallets, but there are also peaks, one waterfall and some valley sectors. Among these, the top three sites could occupy leading positions in a hierarchy of geomorphosites in the Apuseni Mountains due to their unique features, and high values: Vârfuraşu Cave, Răchițele Waterfall and Pietrele Albe klippes.

INTRODUCTION

The inventory of geomorphosites in one given area is practically the first step towards its actual protection, so the need of such demarches, thus the need to identify and asses such landforms, is being more clearly outlined in more and more areas in the country. This paper presents the results of such an initiative, of the inventory and the hierarchy of the geomorphosites in one of the Apuseni Mountains northern parts, the Vlădeasa Massif.

The Vlădeasa Massif has quite clear boundaries to the surrounding areas. Thus, in the north, it extends up to the Crişul Repede river and the Huedin Depression. The eastern border follows a line starting from the village of Călata and leading to the Someşul Cald river, that will become the border for the next sector. The unit's limit then passes north of the Padiş Plateau, all the way to the Crişul Pietros river, that constitutes the border in the southern part. In the west, the border to Pădurea Craiului Mountains follows the Iada Valley (Pop 2000).

Magmatic rocks, the Vlădeasa rhyolites, are the dominant types of rocks in this area. Crystalline schists are also present, especially in the marginal areas, as well as Mesozoic sedimentary rocks. The limestones are present in the south-eastern part only, in the area of the Stanciului Valley.

The Stanciului Valley, also called Valea Seacă (the Dry Valley) in its upper section, has its springs between the Vârfuraşu and the Muntele Crişului peaks, and is a subsidiary of the Secueului Valley.

There are two lanes of limestones in this particular part of the Vlădeasa Mountain, oriented from north towards south and located in the upper valley. The first lane, of large width, is located between the Pietrele Albe klippes and the Muntele Crişului peak, while the second lane is situated inward the Lespezi Ridge. Other small karst surfaces appear, but in an insular manner only (Giuşcă 1950).

Thus, we could have assumed that the main geomorphosites in the Vlădeasa Massif would be of either volcanic nature, either karstic. Still, in this precise area, the magmatic rocks did not give birth to

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any kind of spectacular landmarks, like in the Metaliferi or Călimani Mountains in the Eastern Carpathians. So, again, as in most of the Apuseni mountains, most geomorphosites are to be found in limestones.

POTENTIAL GEOMORPHOSITES IN THE VLĂDEASA MASSIF – GENERAL ASPECTS

Various landforms were taken into consideration in the realization of the Inventory of geomorphosites in the Vlădeasa Mountains, starting from peaks – Vlădeasa (1,836 m), Vârfuraşu (1,686 m), Buteasa (1,739 m) etc., valleys, waterfalls and various elements of the karst landscape.

Inside the last category, the exokastic landforms were fewer and also more modest in size and attractive features: the gorge sector in the Stanciului Valley, the dry valleys and blind valleys formed due to the underground drainages, the corridors of the Lespezi Valley, of Valea Arsă (the Burnt Valley) and of Valea Seacă (the Dry Valley).

However, when analyzing endokarstic forms, their number was much higher, and their diversity was obviously more pronounced.

The explanation lies in the particularity of the Vlădeasa karst, which is quite different from the one in other regions of the Apuseni Mountains (Pădurea Craiului Mountains, Bihor Mountains and especially Trascău Mountains), although we are talking about limestones of the same age and of a karst landscape formed under similar climatic conditions.

In the Vlădeasa Massif, the exokarst is generally quite underrepresented. Forms such as karren, sinkholes or compound dolines are very rare and small. Plus, they do not offer a wide variety of forms and cannot be cited as representative examples. As for gorges, there is only one sector, carved in the middle of the Stanciului Valley. Meanwhile, in the other mountains mentioned above, the index of exokarstification may exceed the development of underground cavities (for example in the Trascău Mountains, although there are also two lames of limestones, the development of large cavities was not possible, and due to the display of rivers, many sectors of gorges of sometimes relevant lengths were formed).

The main cause lies in the partial recrystallization of limestones in the Vlădeasa Massif, the occurrence of a kind of granulation process and the formation of the carbonatic alteration crust. This leads to the chemical saturation of water coming from rain or snow melt, up to the point in which it becomes inactive, thus suppressing the exocarstification (Cocean, Balc 1987).

However, the rhyolite intrusions and the presence of numerous faults, diaclases and cracks in limestones lead to the penetration of the waters inside the bed rock, resulting in underground drainages and therefore, a large number of caves and potholes. According to the same authors, endokarst stands out because of both the large number of underground voids reported to the surface, the density of caves and potholes of 4.68 caves/km² being significantly superior to the national average of 2.27 caves/ km² and the density of cave galleries reported to the surface, 779.7 m/km² in Vlădeasa, compared to 138,8 m/km², the national average. In addition, the highest density of endokarstic networks in Romania has been reported, in fact, for the Stanciului Valley.

In such conditions, the caves were the first to draw our attention. In the Stanciului Valley basin are present a number of 52 underground voids, of which 38 caves and 14 potholes. From the morphogenetic point of view, they belong to the following categories (Cocean, Balc 1987):

– Caves resulting from the formation of underground drainages of insurgency – resurgency type (The Vârfuraşu Cave, The Tău Cave, Peştera cu 6 Intrări – The cave with six entries –, The Lespezi Pothole, etc);

– caves resulting from the formation of slope acquifers, loaded either by diffuse areola infiltration or by partial divagation of the stream of the river (Peştera din Valea Seacă – the cave in the Dry Valley –, caves no. 2, 3, 4 in Valea Arsă etc.);

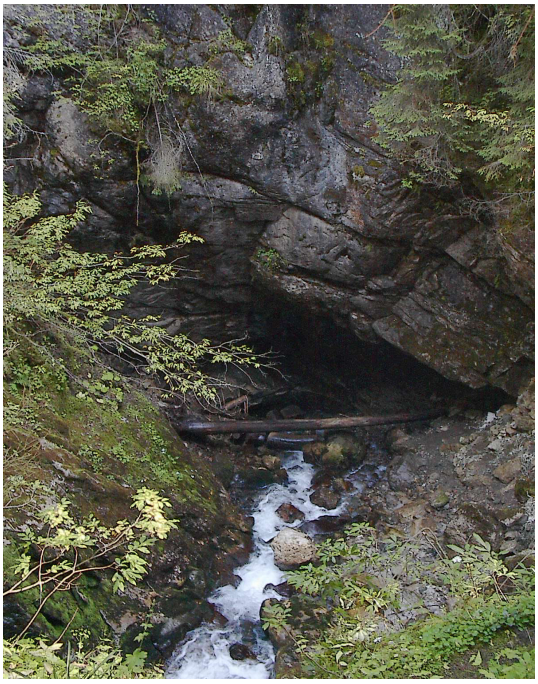

Fig. 1 – The swallet of Peştera de la Tău.

– caves caused by the water infiltration on slopes and organization in the underground as a drainage network (most potholes – Avenul cu Oase, Avenul cu Două Ferestre, Avenul Speranțelor, Avenul cu Spinare, Avenul Bradului, Avenul cu Bârnă, Avenul cu Pui, Avenul din Valea Podurilor, and some caves – Peştera cu Craniu, Peştera lui Susman, The cave no. 5 in Valea Arsă etc.).

Secondly, due to the extensive underground drainage in the Stanciului Valley basin, the number of swallets and exsurgences reported to the surface is impressive. Among these, the most relevant is the Swallet of the Tău Cave, a swallet – doline of 20 m diameter and 14 m depth. There are however other swallets that were taken into consideration: the swallets in the Seacă Valley – Ponorul Peşterii cu Spinare, Tăul Negru, Sitarului Ponor, the swallets in Valea Podurilor valley, Muntele Crişului Ponor, Cetățuia Ponor, Lespezi Ponor, etc. The exsurgences were also considered: Izbucurile de sub Drum, de la Pod, Lespezi karstic springs etc.

GEOMORPHOSITES IN THE VLĂDEASA MASSIF

Only 20 landforms from the ones listed above could truly be classified as geomorphosites, although most of them are picturesque and attractive forms. Some potholes or caves, although might seem interesting, do not have the geomorphological qualities to raise a real scientific interest. Their length and size turned out to be a decisive factor (one will note that in the final list of geomorphosites only caves and potholes superior to 100 m are included), especially in the absence of other interesting features: the novelty of the display, the presence of speleothems, of underground water or of relevant biotopes. Such are the group of pit caves located near the Pietrele Albe klippes, the small caves in the Lespezi or Valea Arsă areas, the caves number 1 and 2 in the Cutii Valley etc.

14 caves and potholes proving a geomorphological, a speleological and a scientific value are the underground cavities that met all the requirements to be assessed as geomorphosites. Besides the Vârfuraşu Cave, whose value is undeniable, some other caves with distinctive attractive features stand

in the final list of the geomorphosites. Such are the caves with an interesting genesis, for example the cave in Valea Seacă, a fossil cave that has a mixed genesis, phreatic, due to the partial infiltration of the waters of Valea Seacă and vadose. Another example is provided by the caves connected by karstic drains: the Lespezi karstic spring, an active cave of 408 m length that owes its existence to the Lespezi Ponor (that can be traced in the list as well). The Lespezi pothole, which is the second cavity in terms of length in the Vlădeasa Mountains, the Tău Cave, with its entrance that hosts an antithetical dam lake when floods occur, have not been omitted. The Runa pothole, with its unique sequence of wells and chambers, the Cave in Muntele Crişului, characterized by the large deposits of montmilch neither.

Two valley sectors: the Stanciului Valley Gorges and the Drăgan Corridor, two peaks: Vlădeasa and Vârfuraşu, the Răchițele Waterfall and the limestone klippes of Pietrele Albe come in addition to these 14 endokarstic geomorphosites, thus resulting in a list of 20 such sites for the Vlădeasa Mountains.

One can note that most of the geomorphosites in this region are punctual geomorphosites, peaks, caves not longer than 500 m, the Răchițele Waterfall. Only two of the most important caves in terms of size, Vârfuraşu and Lespezi Pothole (617 m), and the two valley sectors fall in the linear type of geomorphosites (although the gorge sector is shorter than some caves that are classified as punctual geosites). In fact, the really small number of such sites, of gorges especially, can be considered one of the weak points of the Vlădeasa Massif.

But, the truth is that due to the numerous passes of the waters to the underground, and to the constitution of underground drainages, the rivers did not carve gorges in the Pietrele Albe – Muntele Crişului area. The Stanciului Valley, which runs through the whole limestone area, descents to the underground after only 250 m from its spring, through the swallet of the Cu Spinare Cave, generating a classic dry valley sector of 551 m.

Râşcanilor River, a tributary organized on the left side, reactivates the valley, right before its disappearance in the Tăul Negru Swallet. A right side tributary is partially capturated downstream of this swallet, the waters being oriented towards the Vârfuraşu drainage. After 125 m, the valley disappears in the underground again, in the swallet of the Tău Cave, forming a three kilometers long sector of dry valley, ending with the springs called “under the road” and “under the bridge” (Izbucurile de sub drum and Izbucurile de sub pod).

Thus, the Stanciului river only carved gorges in the median part of the valley. Here, its waters that have been reorganized in the prior, crystalline sector enter the limestone perimeter, gradually deepening the valley by erosion and dissolution. Still, one must admit that this gorge does not possess dimensional or physiognomic highly attractive features, having a length of only 350 m, and a reduced development. But, it has the advantage of being the only gorge in the massif, therefore not entering a competition with any similar forms in the Vlădeasa Mountains.

Some of the selected geomorphosites only have a geomorphological, or speleological interest, while others also have a hydrographical, or hydrogeological relevance: The Răchițele Waterfall, Izbucurile „de sub drum” springs, or the caves that stand out as relevant karst drainages, such as the Vârfuraşu cave, or Lespezi Pothole and Lespezi karst spring. There are other geomorphosites that even have landscape relevance, such as the Pietrele Albe klippes and the Vlădeasa Peak.

The assessment method already successfully used for the inventory of the geomorphosites in the Trascău Mountains (Cocean 2011) has also been used in this study. The method aims to quantify both structural and functional value of geomorphosites. The structural value represents the sum of geomorphological, aesthetic and ecological values, while the functional one is the sum of scientific, cultural and economic value. The mathematical value of the restrictive attributes is subtracted from the sum of the structural and functional values, resulting the general value of the geomorphosite (Table 1).

Table 1

Geomorphosites in the Vlădeasa Mountains

CRT NO	GEOMORPHOSITES	Structural Value			Functional Value			RA	TOTAL
		VS1	VS2	VS3	VF1	VF2	VF3		
1	Vârfurașu Cave (Peștera cu Bănci, Peștera cu Gheață)	6.5	2.75	1	1.5	3.75	4	1,75	17,75
2	Răchițele Waterfall	4.25	1.75	1	0.75	4.25	5	1.5	15.5
3	Pietrele Albe	4.25	3	0.75	0.5	3.25	4	1.5	14.25
4	Stanciului Valley Gorges	2.5	1.75	0,75	1.75	2.75	4.75	1.25	11.25
5	Vlădeasa Peak	2.75	2.25	0.75	1	1.5	4.25	1.25	11.25
6	Lespezi Pothole	4.25	1.5	0.25	0.25	2.5	2	1.5	9.25
7	Tău Cave (Peștera de la Tău, Peștera Ponor din Valea Seacă)	3	1.5	0	0.25	1.25	3.25	0.5	8
8	Vârfurașu Peak	2.5	1.75	0.75	0.25	1.25	2.5	1.25	7.75
9	Izbucul Lespezi (the Lespezi karst spring)	2	1	0	0.25	1.5	3	0.5	7.25
10	Peștera din Valea Seacă (dr. Balogh Ernö Cave)	2.5	1.25	0	0.25	1.25	3	0.5	7
11	Runa Pothole	2.25	1.25	0	0.75	1	1.75	0.5	6,5
12	The Cave from Lespezi	2.25	1.25	0	0.25	1.25	2	0.5	6.5
13	The number 2 cave from Lespezi	2.25	1.25	0	0.25	1.25	2	0.5	6.5
14	Avenul cu Spinare (Avenul din Fundul Muntelui)	2.25	1.25	0	0.25	1.25	2	0.5	6.5
15	Izbucurile „de sub Drum”	1.5	1	0	0.25	1	3	0.5	6.25
16	Drăgan Corridor	1.75	1	0.5	0.25	1	2.75	1	6.25
17	Lespezi Pothole	1.5	1	0	0.25	1	2.75	0.5	6
18	Muntele Crișului Cave	1.25	1	0	0.25	1.25	2.5	0.5	5.25
19	Peștera-ponor din Valea Arsă (The ponor-cave of Valea Arsă)	1.25	0.75	0.5	0.25	1	2	0.5	5.25
20	The number 3 cave from Cuții Valley	1.5	1	0	0.25	1	1.5	0.5	4.75

If we take a minute to analyze the results of the assessment of each geomorphosite, we can note two interesting facts about the sites in this area. The Vârfurașu Cave, the Lespezi Pothole, the Pietrele Albe Klippes and the Răchițele Waterfall are the four sites of high or very high geomorphological value, the rest of the geosites in the list having a more average or even modest rate.

The second observation concerns the rather low scientific value that these geomorphosites have. Except the Stanciului Gorges and the Vârfurașu Cave, sites that have an average value. If one analyzes the scientific literature dedicated to the Vlădeasa Mountains, one would note that the massif has been described together with the Bihor Mountains (Giușcă 1950). Many authors did that in their books, articles or travel guides (Bleahu, Bordea 1995). The Bihor Mountains, besides being the tallest part of the Apuseni Mountains, are particularly rich mountains in terms of gorges, caves, swallets or karst springs, thus, Vlădeasa has always received less consideration for its treasures in such studies, therefore the low scores for the scientific interest it has raised.

In terms of the hierarchy of geomorphosites in the Vlădeasa Massif, the situation does not seem too surprising. The first three geomorphosites are well detached in value: the Vârfurașu Cave, The Răchițele Waterfall and Pietrele Albe, three landmarks that can compete with many other important geomorphosites in the Apuseni Mountains.

The Vârfurașu Cave, also known as Peștera cu Gheață (The Ice Cave, due to accumulations of ice at the entrance, in the cold season) or as Peștera cu Bănci (The Cave with Benches, as a consequence of erosion levels present in the same sector). Located on the left side of the Valea Seacă corridor, it is the most developed endokarstic form of the Vlădeasa Massif, as well as the biggest and best known cave in the Cluj County.

Its genesis is quite complex and is explained by the capture in the underground of three rivers: Sitarului, Muntelui and Râşcani, near the lithologic contact area between limestone and magmatic rocks (Cocean 1995).

It is 4500 m long (the CSA inventory 2007) and has an oscillation in level of 40 meters, oscillation that we consider to be rather small reported to its length. But the charm and the value of the Vârfuraşu Cave do not lie neither in the length or depth, but in the richness of the Galeria Albă (White gallery), that hides beautiful montmilch stalactites, stalagmites, columns and curtains. In addition, parallel to the White Gallery, there is another gallery of high attractiveness where lakes and parietal leakages can be admired.

The touristic "exploitation" of the Vârfuraşu Cave, not only through speleotourism, but its introduction within the sphere of geotourism, although possible, requires a certain amount of arrangements that would facilitate the access and allow underground navigation on short sectors (Cocean 2007).

In the second place of the hierarchy there is the *Răchiţele Waterfall*, of 30 m high. It formed due to the different behavior of crystalline rocks and limestone. Thus, in the crystalline rocks, the valley remains well suspended, being connected to the lower part, carved in limestones by the steep scarp on which the waterfall is located.

The two steps waterfall also known as the Vălul Miresei Waterfall (The Bride's Veil) is now the main point of attraction in the Vlădeasa Massif. The possibility to practice climbing, especially in winter time, on the ice wall that forms near the waterfall, the installing of a Tyrolien traverse in the summer time, the particularly favorable position in relation to the main access road all stimulate the touristic flow towards this landmark.

Fig. 2 – Răchiţele Waterfall.

Fig. 3 – Pietrele Albe klippe.

Pietrele Albe, like other isolated massifs, have a major impact upon the landscape, due to their sudden appearance in the landscape, as a residual, suspended relief, of completely different features compared to the surrounding landforms. In addition, the white color of the klippes stands out, giving the landscape a superior aesthetic touch.

Pietrele Albe also seem to be privileged by their location, away from other similar forms, that appear mostly in the Metaliferi and Trascău Mountains, being the only classic example of klippes in the northern part of the Apuseni Mountains.

They represent a complex geomorphosite (with an overall general value that allows comparisons with other isolated massifs in the Trascău Mountains, Corabia or even Dâmbău) which includes several interesting elements, and even another geomorphosite. At the base of the steep slopes, there is a group of pit caves, Avenul cu Oase, Avenul cu Două Ferestre, Avenul Speranţelor, Avenul cu Spinare, Avenul

Bradului, Avenul cu Bârnă and Avenul cu Pui. Most of these potholes are small, 6–27 meters depth and they have a morphology typical for forms developed in the points of intense dissolution. In the same perimeter, there is also the Avenul cu Spinare pothole, a geomorphosite that can be seen on the final list of geomorphosites.

Another wealth of the Pietrele Albe formation are the karren developed on their scarps, this being the only place in the Vlădeasa Mountains where karren are present, in the rest of the massif, their development being inhibited by the above mentioned alteration crust.

CONCLUSIONS

In the process of identifying the geomorphosites in the Vlădeasa Massif, the uniqueness of these particular mountains reveals. In a massif formed mainly by magmatic and metamorphic rocks, the majority of geomorphosites belong to the karst landscape, a kind of landscape that has completely different features in comparison to the karst landscape in other massifs in the Apuseni Mountains. Thus, most geomorphosites in Vlădeasa are endokarstic forms, caves and potholes.

One can note the concentration of these geomorphosites in the basin of Stanciului valley. The small distances between geomorphosites are in fact beneficial for it is much easier to protect nearby landmarks. In addition, it is easier to include such close sites in the geotouristic tours.

However, one must bear in mind the fact that the Stanciului Valley is located near the Someşul Cald basin (with Cetățile Rădesei, Peştera din Valea Firei – Humpleu and Peştera Altarului caves) as well as near the Padiş Plateau, where a large number of very valuable caves is present (Cetățile Ponorului, The Zăpodie System, Gheţarul Barsa, Gheţarul Focul Viu etc).

Thus the Stanciului Valley will be permanently placed in the same balance with these areas, risking to enter an unfavorable attractive outshine at any time. But, even if the caves and gorges in the Someşul Cald basin or the Padiş Plateau exceed in value the similar forms in the Stanciului Valley, the Răchițele Waterfall and the Pietrele Albe Klippes are unique in an obvious manner.

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