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TOPOGRAPHICAL PROMINENCE OF THE PEAKS FROM FĂGĂRAŞ MOUNTAINS (ROMANIA) WITH RELEVANCE TO THE MOUNTAIN ACTIVITIES. METHODOLOGICAL AND PRACTICAL ASPECTS

IOAN BÎCA[1]

ABSTRACT. The peaks of the mountains have aroused the interest of people since ancient times. The route to get there, the difficulty of climbing, the view that was visible to the eyes there were challenges for everyone. And these turmoils, generated, over time, a special activity that targeted the mountain tops, mountaineering. From the moment Mont Blanc was conquered (Balmat, Paccard, 1786), then Everest (Hillary, Tenzing, 1953), mountain lovers are constantly looking to reach the peaks, to get drunk with ephemeral success, and become conquerors of useless (Terray, 1961). But the peaks, in addition to being bastions that need to be attacked, are also distinguished by geomorphometric approaches, and one of these approaches is the prominence, a parameter that represents the level difference by which a peak jumps over its base from the surrounding regions. Therefore, the higher this jump, the more important the tip is for mountaineers, and the more it should be included in the list. In this context, this paper aims to analyze and establish the prominence of the peaks of the most coveted mountain massif in the Romanian Carpathians, namely Făgăraş Mountains, highlighting a practical side of the problem, materialized by the methodological approach included in the research.

Keywords: *mountain prominence, key-saddle, key col, line parent chain, parent-peak, mountain hierarchy, orometric dominance, mountaineering*

REZUMAT. ***Proeminența topografică a vârfurilor din Munții Făgărașului (România), cu relevanță pentru activitățile agrementale montane. Aspecte practice și metodologice.*** Vârfurile munților au stârnit interesul oamenilor din cele mai vechi timpuri. Drumul până acolo, dificultatea de a urca, priveliștea care se dezvăluia ochilor de acolo, erau provocări pentru oricine. Și aceste frământări, au generat, peste timp, o activitate aparte care viza vârfurile munților, muntenăria. Din momentul în care a fost cucerit Mont Blancul (Balmat, Paccard, 1786), apoi Everestul (Hillary, Tenzing, 1953), iubitorii muntelui își doresc neîncetat

[1] *Babeş-Bolyai University, Faculty of Geography, Cluj-Napoca, Romania, john_grimo@yahoo.com.*

să ajungă pe vârfuri, pentru a se îmbăta cu un succes efemer şi a deveni cuceritori ai inutilului (Lionel Terray, 1961). Dar vârfurile, pe lângă faptul că sunt bastioane care trebuie asaltate, se disting şi prin abordări geomorfometrice, iar una dintre aceste abordări este proeminenţa, parametru care reprezintă diferenţa de nivel prin care un vârf saltă peste baza sa faţă de regiunile înconjurătoare. Prin urmare, cu cât acest salt este mai mare, cu atât vârful este mai important pentru muntenari şi cu atât mai mult trebuie inclus în palmares. În acest context, lucrarea de faţă îşi propune să analizeze şi să stabilească proeminenţa vârfurilor din cel mai râvnit masiv montan din Carpaţii Româneşti, respectiv Munţii Făgăraşului, scoţând în evidenţă şi o latură practică a problemei, materializată prin demersul metodologic inclus în cercetare.

Cuvinte-cheie: *proeminenţă montană, înşeuare-cheie, dominanţă orometrică, turism montan*

Introduction

Peaks, as geographical entities, can be defined from two perspectives:

1) As a position within a morphographic system: the peaks represent geomorphological structures located at the upper terminal part of a mountain (height) = the top of the mountain (fig. 1).

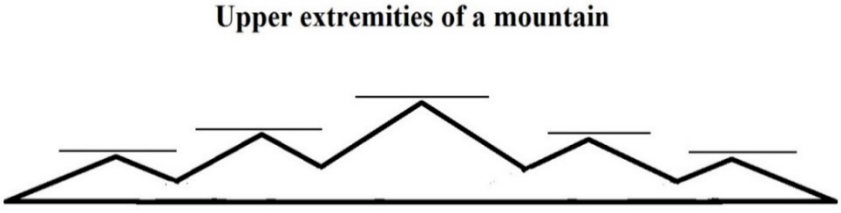

Fig.1. Peaks position on a mountain ridge

2) As geomorphology: the peaks represent prominences located in the plane of the ridges (rise), defined by specific morphographic elements (base, shape, flanks, upper extremity) and morphometric elements (altitude, inclination, and length of the flanks, level difference between base and upper extremity) (fig.2). As such, the prominence is the level difference between the base of a peak, called the "key saddle" or "key col", and its upper extremity (top).

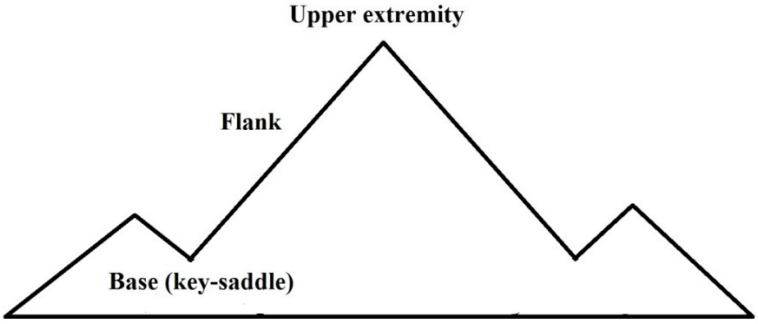

Fig. 2. The morphographic elements of a peak

These geomorphological structures appeared in the process of modeling mountain spaces, their detachment contributing to petrography (rock type), structural heritage (the position of geological bodies), hydro-atmospheric factors (precipitation, thermal variations, winds, ice), biogeographical factors (the action of vegetation, organisms) and anthropogenic factors (man and his activities).

For this reason, certain genetic (age), altimetric (height), and spatial (distance between peaks) ratios are established between the peaks located on a certain mountain ridge. The genetic point of view is very important in establishing prominence because the peaks differ from each other in rank. The highest peaks are considered "parent peaks", and the peaks below their altitude represent "sub-peaks", ranked in peaks of rank I, II, III, etc. In this context, the lower rank peaks are subordinated to the higher rank peaks, and their prominence is established about to them (fig.3). Finally, all sub-peaks are subordinated to the parent peak, in a so-called line of genetic descent (lineage).

For practical reasons, this article will address the peak as a geomorphological structure (landform), and the parameter that interests us, in connection with it, is the prominence (rise), which can be defined as the level difference between the base of the peak (key saddle), and its upper extremity (top).

The value of prominence is relevant in mountain recreational activities, as the peaks are attractions that must be escalated for several reasons:

-are the highest surfaces of the mountain, which attract attention and interest;

-provides viewpoints over the surrounding regions;

-involves special physical and mental demands to be achieved;

-constitutes targets with competitive sports connotations.

Because of this, the altitude and prominence of the peaks, along with the aesthetic component, induced by shape (conical, pyramidal, domed) and detailed relief of the flanks (slopes, steps, cliffs, ravines, ridges, glacial circuses, debris fields, etc.), are the most important reasons for practicing mountain recreational activities.

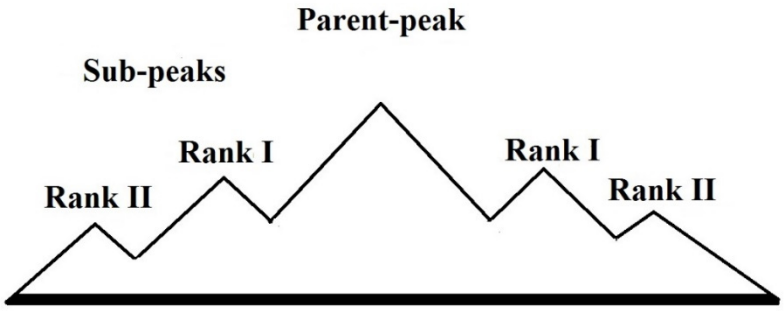

Fig. 3. The ranks of the peaks

Literature review

Concerns about establishing topographic prominence began in Britain in the late 19th century, when attempts were made to establish geomorphological structures with "mountain" status in England, Wales, and Ireland (Nuttall, Nuttall, 1989, 1990); Dawson, 1992; Dewey, 1995; Dawson, 1997a; Dawson, 1997b; Bearhop, 1997, Jackson, 2009). For this, the altitude of the structures and the minimum prominence of the peaks were taken into account.

Thus, the structures that had an altitude over 600 m and the minimum prominence over 15 m (30, 55, 150 m) were considered mountains. In 1991, Richard Goedeke set the minimum prominence of a peak of importance for mountaineering, at 30 m, as the classic length of rope for mountaineering, a value also adopted by the UIAA in 1994. In the US, the minimum value of the prominence of an important peak is 91 m. For the Alps, the works of Höhne (1993), Grimm and Mattmüller (2004), Helman (2005), and Goedeke (2006) can be mentioned. At a general and methodological level, the works of Schmidt and Stumme (2018), and Stubbemann et al. (2019) are recommended.

Study area

The Făgăraş Mountains are located in the Southern Carpathians (Făgăraş Group), between the Olt Valley (W), the Bârsa Groşetului-Dâmboviţa Valleys (E), the Făgăraş Depression (N) and the alignment of the Câmpulung, Brădetu, Arefu and Jiblea depressions (fig. 4). The present study considers the main ridge, developed sinuously, from west to east, on a length of 87 km, between Olt Valley (360 m) and Curmătura Foii Saddle (1350 m), within which are the highest peaks and a spectacular relief, with glacial and periglacial forms (glacial circuses, glacial valleys, moraine mounds, cusps, cliffs, peaks, chimneys, ravines, lathes, and rubble) modeled on metamorphic rocks (crystalline shales) (fig. 5).

Fig. 4. Geographical position of Făgăraş Mountains in Romanian Carpathians (source: ro.Wikipedia.org-with changes)

Fig. 5. Longitudinal profile of Făgăraş Mountains (source: MapMyHike.com-with changes)

Methodologies

For the elaboration of this article, several methodological steps were followed, as follows:

a) Analysis of the topographic map and extraction of the peaks from the main ridge (table 2).

- for this operation, the online topographic map of Romania was used, with a scale of 1: 25000, the equidistance of the main level curves of 50 m, from the website of the Military Topographic Directorate: (https://portal.geomil.ro/portal/home/ web map / viewer.html).

b) Elaboration of the diagram of the peaks on the main ridge, according to the data from table 2 (fig.6).

- for this operation the Paint program was used, where on a millimeter sheet the axis of the altitudes from 100 to 100 m was drawn, at a distance of 2 cm, then the altitudes of the peaks and saddles between them were scored.

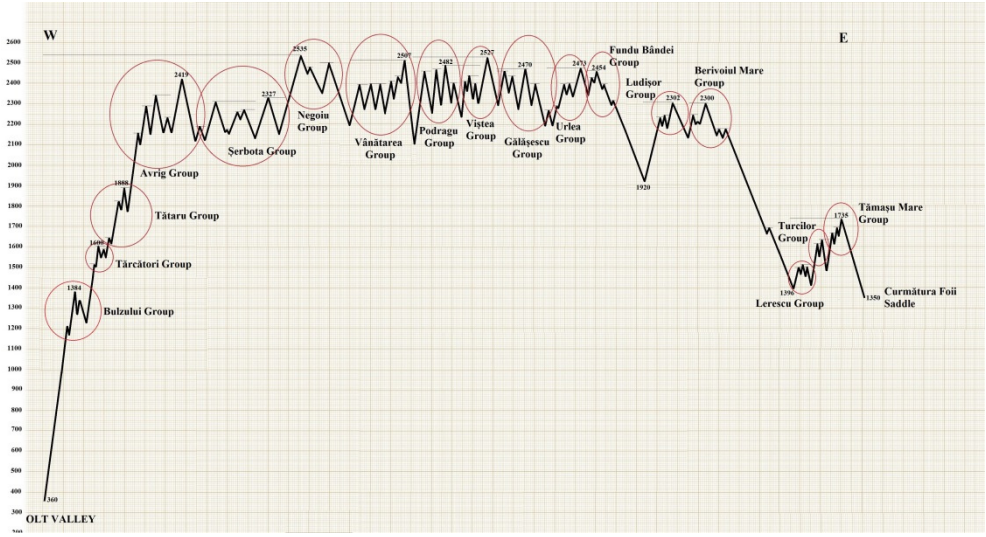

Fig. 6. The diagram of the peaks of the main ridge in Făgăraș Mountains (source: Topographic Map of Romania, 1: 25 000)

c) Grouping the peaks based on the subordination relations between them:

- in the modeling process of the main ridge several peaks resulted, between which there are certain relations of genetic, spatial, and altimetric subordination (fig.6);

- Negoiu (2535 m), and Viştea Mare (2527 m) - Moldoveanu (2544 m) duet can be considered as parent-peaks;

- the other peaks on the main ridge were grouped, on the same subordination criteria, around first-order peaks, as follows (table 1).

Table 1. Grouping the peaks on the main ridge of the Făgăraş Mountains, according to their order

Main group	**Main peaks/First order**	**Subordinated peaks/Second and third order**
Avrig	Bulz	Drăghicioaia, Bulz, Repezoi
	Tărcători	Strâmbaru, Tărcători
	Tătaru	Prislop, Tătaru
	Avrig	Suru Mic, Suru Mare, Budislavu, Vârtoapele, Gârbova
Negoiu	Şerbota	Gârbova, Scara, Puha, Scărişoara, Scăriceaua
	Negoiu	Portiţei, Călţun, Curmăturii
Vânătarea lui Buteanu	Vânătarea lui Buteanu	Lăiţel, Laiţa, Paltinu, Capra, Văiuga
Viştea-Moldoveanu	Podragu	Vârtop, Arpaşu Mare, Tărâţa
	Ucea	Corabia, Ucişoara
	Gălăşescu Mare	Hârtopu Ursului, Galbenele, Gălăşescu Mic, Slănina
Urlea	Mogoş	Slănina, Colţul Bălăceni, Cheia Bândei
	Fundu Bândei	Iezer, Geamăna, Leaota
Ludişoru	Ludişor	Zîrna, Langa
	Berivoiul Mare	Pietrele Popii, Belia, Laptele, Luţele, Cornişu Mic
Tămaşu Mare	Lerescu	Rudăriţa, Lerescu Mare, Lerescu Mic
	Turcilor	Piscul Mănăstirii
	Tămaşu Mare	Ciocinea, Răchita Mare

d) Establishing key saddles and topographic prominences:

- for this operation, the graph of the peaks on the main ridge was analyzed and the subordination relations between them were established, after which the key saddles were established for each peak (fig.6);

- based on these key saddles, the prominence of each peak was calculated by the following formula:

Pp= Pa-KSa, where Pp = peak prominence, Pa = peak altitude, and KSa = key saddle altitude (table 1)

e) Establishing the orographic dominance:

- after calculating the prominences, the orographic dominance of each peak was calculated, based on the formula Od = Pp / Pa x100, where Od = orometric dominance, Pp = peak prominence, and Pa = peak altitude;

- the orometric dominance shows us the importance of the respective peak in the orographic system of the Făgăraş Mountains and within the main ridge;

- the smaller the difference between the value of the prominence and the altitude of the peak, the higher the orometric dominance / the higher the prominence, the higher the orometric dominance;

- the peaks with high prominence are also distinguished by high values of orometric dominance;

- the most prominent and dominant peaks are Negoiu, Vişţea Mare, and Moldoveanu (table 2).

Results and discussions

Based on the Topographic Map, scale 1:25 000, published in 1984 by the Military Topographic Directorate, we established within the main ridge of the Făgăraş Mountains 69 peaks, between 1200 m and 2544 m. Of these, four peaks have the altitude of 2500 m (Moldoveanu, 2544 m; Negoiu, 2535 m; Vişţea Mare, 2527 m; Vânătoarea lui Buteanu, 2507 m).

The parent peaks on this ridge are Negoiu (2535 m) and the Vişţea Mare-Moldoveanu duet (2527-2544 m), which are testimonies about the altitude and the initial configuration of the mountainous terrain. Peaks below these altitudes are considered sub-peaks and are grouped based on genetic, altimetric, and spatial subordination ratios, which facilitate the establishment of key saddles and the value of the prominences. Based on the methodology presented above, the following values of orometric prominences and dominances were obtained (table 2).

Table 2. Topographic parameters of the peaks on the main ridge of the Făgăraş Mountains

Crt no.	Peak	Elevation m	Key saddle m	Proeminence m	Orometric dominance m	Status
1	Drăghicioaia	1210	1170	40	3.30	Peak
2	Bulzului	1384	1240	114	8.23	Peak
3	Repezoi	1341	1270	71	5.29	Peak
4	Strâmbaru	1511	1490	21	1.38	Summit
5	Tărcători	1600	1550	50	3.12	Peak
6	Comarnic	1587	1550	37	2.33	Peak
7	Prislopul Mic	1640	1620	20	1.21	Summit
8	Prislop	1820	1780	40	2.19	Peak
9	Tătaru	1888	1770	118	6.25	Peak
10	Suru Mic	2153	2100	53	2.46	Peak
11	Suru Mare	2283	2150	133	5.82	Peak
12	Budislavu	2343	2160	183	7.81	Peak
13	Vârtoapele	2233	2160	73	3.26	Peak
14	Avrig	2419	2120	299	12.3	Peak
15	Gârbova	2188	2120	68	3.10	Peak
16	Scara	2306	2160	166	7.19	Peak
17	Puha	2176	2150	26	1.19	Summit
18	Scărişoara	2261	2220	91	4.02	Peak
19	Scăriceaua	2270	2130	140	6.16	Peak
20	Şerbota	2327	2150	177	7.60	Peak
21	Negoiu	2535	360	2175	85.79	Peak
22	Portiţei	2476	2350	282	11.38	Peak
23	Călţun	2500	2300	200	8	Peak
24	Curmăturii	2210	2194	16	0.72	Summit
25	Lăiţel	2391	2270	121	5.06	Peak
26	Laiţa	2399	2270	110	4.58	Peak
27	Paltinul	2399	2250	149	6.21	Peak
28	Capra	2410	2320	90	3.73	Peak
29	Văiugii	2430	2400	30	1.23	Peak
30	Vânătarea	2507	2194	313	12.48	Peak
31	Vârtop	2460	2250	210	8.53	Peak
32	Arpaşul Mare	2468	2290	178	7.21	Peak
33	Podragu	2482	2300	182	7.33	Peak
34	Tărâţa	2400	2300	100	4.16	Peak
35	Corabia	2406	2360	46	1.91	Peak
36	Ucea Mare	2434	2300	134	5.50	Peak
37	Ucişoara	2399	2320	79	3.29	Peak
38	Viştea Mare-Moldoveanu	2527-2544	360	2167-2184	85.75-85.84	Peaks
39	Hârtopul Ursului	2454	2290	164	6.68	Peak
40	Galbena	2436	2350	86	3.53	Peak

Crt no.	Peak	Elevation m	Key saddle m	Proeminence m	Orometric dominance m	Status
41	Gălășescu	2470	2290	180	7.28	Peak
42	Gălășescu Mic	2398	2290	108	4.50	Peak
43	Slănina	2268	2190	78	3.43	Peak
44	Colțu Bălăceni	2286	2280	6	0.26	Summit
45	Cheia Bândei	2381	2340	41	1.72	Peak
46	Mogoș	2398	2330	68	2.83	Peak
47	Urlea	2473	2190	283	11.44	Peak
48	Iezer	2429	2400	29	1.19	Peak
49	Fundu Bândei	2454	2336	118	4.80	Peak
50	Geamăna	2386	2370	16	0.67	Summit
51	Leaota	2312	2290	22	0.95	Summit
52	Zârna	2231	2190	41	1.83	Peak
53	Langa	2242	2180	62	2.76	Peak
54	Ludișoru	2302	1920	382	16.59	Peak
55	Pietrele Popii	2247	2200	47	2.09	Peak
56	Belia	2212	2200	12	0.54	Summit
57	Berivoiul Mare	2300	2125	175	7.60	Peak
58	Laptele	2171	2140	31	1.42	Peak
59	Luțele	2176	2130	46	2.11	Peak
60	Cornișu Mic	1690	1660	30	1.77	Peak
61	Rudărița	1494	1460	34	2.27	Peak
62	Lerescu Mare	1503	1407	96	6.38	Peak
63	Lerescu Mic	1499	1450	51	3.40	Peak
64	Piscul Mănăstirii	1613	1550	63	3.90	Peak
65	Turcilor	1631	1484	147	9.01	Peak
66	Ciocinea	1652	1610	42	2.54	Peak
67	Răchita Mare	1682	1650	32	1,90	Peak
68	Tămașu Mare	1735	1396	339	19.53	Peak

Geomorphological structures that are distinguished by prominences over 30 m were considered peaks, and those below this value were declared heights (summits).

Regarding the orometric dominance of the peaks, as a ratio between Pp and Pa (Od = Pp / Pa x100), the following aspects emerged:

- the higher the peaks prominences (Pp), the higher the orometric dominances (Od);

- Pp depends on the altitude of the key saddle (the deeper the key saddle, so it has a higher value, the higher the Pp, and the higher the orometric dominance);

- if the key saddle is deep, it means that erosion has been strong, which is observed in high prominence and high orometric dominance;

- usually, the peaks with major Od group around them are peaks of lower rank.

Based on the results obtained, the following orometric classes were established:

1) Class 0-3: Curmăturii (0.72), Puha (1.19), Prislopul Mic (1.21), Prislop (2.19), Luţele (2.11), Comarnic (2.33), Tărcători (3.12), Drăghicioaia (3.30) etc.;

2) Class 4-6: Scărişoara (4.02), Tărîţa (4.16), Gălăşescu Mic (4.50), Laiţa (4.58), Fundu Bândei (4,80), Lăiţel (5,06), Repezoi (5,29), Ucea Mare (5,50), Suru Mare (5,82), Scăriceaua (6.16), Paltinu (6.21), Tătaru (6.25), Lerescu Mare (6.38), Hârtopul Ursului (6.68);

3) Class 7-9: Scara (7.19), Arpaşu Mare (7.21), Gălăşescu (7.28), Podragu (7.33), Şerbota (7.60), Berivoiul Mare (7.60), Budislavu (7.81), Călţun (8), Bulzului (8.23), Vârtop (8.53), Turcilor (9.01);

4) Class 11-12: Portiţei (11.38), Urlea (11.44), Gârbova (12.3), Vânătarea (12.48);

5) Class 16-19: Ludişoru (16.59), Tămaşu Mare (19.53);

6) Class 85 (parent-peaks): Viştea Mare (85.75), Negoiu (85.79), Moldoveanu (85.84).

Conclusions

The present study established the geomorphometric status of the peaks on the main ridge of the Făgăraş Mountains, the most coveted mountain massif in Romania. Thus, peaks with prominences over 30 m can be considered peaks proper, and those below this value represent only heights (summits), which is included in a certain hierarchy of preferences for mountaineers.

Through its genesis, altitude, shape, detailed relief, and prominence, the peaks of the Făgăraş Mountains represent landmarks that must be reached by those who carry out recreational activities on the mountain. In this context, the peaks have a double meaning: a sports-leisure significance (the last alignment, a finish line) and a psychological significance (challenge, record).

Regarding the importance of the peaks of the main ridge in the Făgăraş Mountains for mountain leisure activities, they are distinguished by:

1) Scenic relevance:

- tops are viewpoints;

2) Cultural relevance:

- tops have mythical connotations;

3) Sports relevance:

- high points that must be climbed through physical and mental performance;
- high points that launch challenges;

4) Strategic relevance:

- natural boundaries between administrative units;

5) Ecological relevance:
- the peaks preserve components of the environment (relief, plants, animals);

6) Psychological relevance:
- an obstacle to be overcome;
- challenge to be accepted;
- objective that must be included in the record.

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