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THE PROMINENCE OF THE PEAKS FROM RODNEI MOUNTAINS (ROMANIA) WITH RELEVANCE FOR MOUNTAINEERING. METHODOLOGICAL AND PRACTICAL ASPECTS

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ABSTRACT. In recent years, mountain leisure activities in Romania recorded spectacular growth, due to several factors, such as: technical progress in the field of mountain equipment, increased leisure and circulation of information on the internet or in the media. If in the past, mountain tourism activities belonging, to a certain extent, of niche tourism, today they fall into mass tourism and one of the criteria that attract the mountaineers to mountain areas is altitude and prominence of the peaks. The higher the altitude, the more attractive and competitive the respectively peak. The prominence is a parameter that refers to the gap between top and base of the peak, marked by neighboring saddles called key-saddles or key-col. According UIAA, minimal prominence for a mountain/hill structure to be considered peak with relevance for sports activities is 30 m (a rope length). Between altitude and prominence of the peak is not necessarily a relation, therefore, often, more important is the last one, who actually, identifying the peak. Therefore, in this study it approached Rodnei Mountains area, which was manually calculated the prominence of the peaks from main ridge, in order to underline the importance of this sector for various leisure activities.

Key words: *mountain tourism, mountain leisure, mountaineering, key-saddle, base level, independent peak, parent peak, orometric dominance*

REZUMAT. ***Proeminența vârfurilor din Munții Rodnei, cu relevanță pentru muntenărie. Aspecte metodologice și practice.*** În ultimii ani, agrementul montan din România a înregistrat creșteri spectaculoase datorită mai multor factori, cum ar fi: progresul tehnic din domeniul echipamentului montan, creșterea veniturilor, creșterea timpului liber și circulația informației pe internet sau în mass media. Dacă în trecut, activitățile turistice montane aparțineau,

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într-o anumită măsură, turismului de nișă, astăzi acestea se încadrează în turismul de masă, iar unul dintre criteriile care atrag muntenarii spre arealele montane este altitudinea şi proeminenţa vârfurilor. Cu cât este mai mare altitudinea, cu atât este mai atractiv şi mai competitiv vârful respectiv. Proeminenţa este un parametru care se referă la diferenţa de nivel dintre creştetul vârfului şi baza sa, marcată de înşeuările limitrofe, numite înşeuări-cheie. Conform UIAA, proeminenţa minimă, pentru ca o structură montană să fie considerată vârf cu relevanţă pentru activităţi sportive este 30 m (o lungime de coardă). Între altitudinea şi proeminenţa vârfului nu este, neapărat, o legătură, de aceea, de multe ori, este mai importantă aceasta din urmă, care individualizează, de fapt, vârful. Prin urmare, în studiul de faţă s-a abordat arealul Munţilor Rodnei, pentru care s-a calculat manual proeminenţa vârfurilor de pe culmea principală, cu scopul de a sublinia importanţa acestui sector pentru diferitele activităţi agrementale.

Cuvinte cheie: *turism montan, agrement montan, înşeuare-cheie, nivel de bază, vârf independent, vârf părinte, dominanţă orometrică*

Introduction

In recent years, mountain tourism and leisure of Romania boomed due to several factors, such as:

-technical progress registered in the field of mountain equipment (shoes, clothes, accessories) and easy access to the equipment through classic stores (Decathlon, Nootka Alpin Expe, Mormota Land, Atta, Himalayas, Maia Outdoors, Maramont Edelweiss Outdoor Shop Montrek, etc.) and their online versions;

-founding of several mountain travel agencies, such as: Altitude Expedition Team, Extreme Travel, Experts Summits, Extreme Expedition etc.

-access to information via Internet (social networks, blogs, vlogs, articles, advertisements, videos);

-free movement of tourists within the European area;

-easy access to mountainous areas (roads, transport);

-increasing leisure.

Therefore, mountaineering, previously considered niche tourism, became a mass phenomenon, which tends to move in the recreational area in the sports performance by moving the center of interest for climbing high peaks of the Carpathians (over 2,000 m). These peaks are characterized by certain parameters, such as: elevation (altitude above sea level), the shape (sharp, rounded, angled, pyramid) and the prominence.

The prominence is the difference in height between the top and base of the peak, expressed through a low area, adjacent, called key-saddle or key cool. This parameter, called height/autonomous altitude, correlates with the relative altitude and resulting in deep erosion exerted by external agents.

Concerns about establishing minimum prominence began in the UK, while trying to identify geomorphological structures according to the "mountain" in England, Wales and Ireland.

Thus, in 1891, Sir Hugh Munro considered that a mountain have a height of at least 900 m (914 m), and a prominence of at least 55 m and is sufficiently isolated from other mountains. In 1920, John Rooke Corbett incorporate in mountains list the geomorphologic units with altitude of 762 -914 m, and 150 m minimum prominence.

In 1935, Percy Donald believes that mountain units are between 610-833 m and minimum prominence is 30.5 m. John and Anne Nuttall in the guide "The Mountains of England and Wales" (1989, 1990) believes that the prominence must go 15 meters and height of the mountains from 610 m. In 1992, Fiona Graham published a list where mountain peaks are between 610-762 m, with the prominence of at least 150 m, and Alan Dawson, in "The Relative Hills of Britain" (1992), prepare the Marilyns list, considering the prominence as at least 150 m on all sides of the mountain.

Richard Goedeke (1991) decides to use to define the minimum prominence of a peak, with relevance for mountaineering, a classical length of a climbing rope, 30 m. In 1994 the UIAA take this condition and sets the minimum value of the prominence for a peak to be considered independent, 30 m (length of a climbing rope).

In 1995, Michael Dewey publishes "Mountain Tables: Tables of the mountain and hill summits of England and Wales", which the mountains units are between 500-610 m, and the minimum prominence of at least 30 m. In 1997, Alan Dawson publishes the Hewitt list, which includes mountain peaks between 610-1085 m and minimum prominence is 30 m.

In the US, the minimum value of the prominence, for a geomorphological structure to be considered independent peak, is 91 m, and the prominence of 600 m defines peaks with important status.

Independent peaks or parent peaks are the peaks with high prominence and the peaks of their vicinity is considered sub-peaks (fig. 1). Another parameter that is used for mountain climbing hierarchy is orometrical dominance, defined as the difference between the mountain elevation and the prominence (P / Alt * 100). This indicates the percentage dominance of a mountain peak within a mountain system.

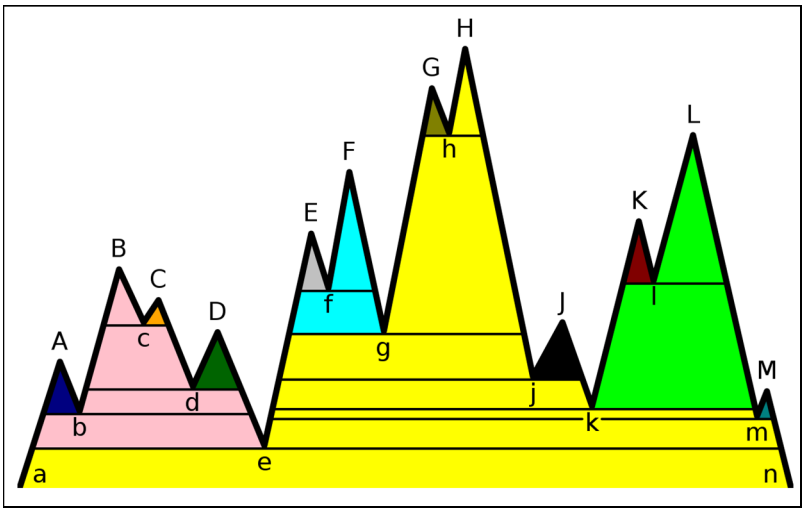

Fig. 1. The prominence principle. H=parent peak; B, F, G, J, L, M=sub-peaks of Rank I; A, C, D, E, K=sub-peaks of Rank II-III. a-n=key saddles
(Source: https://en.wikipedia.org/wiki/Topographic_prominence)

Besides technical importance, orometric prominence have a psychological relevance on performance, because the peaks with great prominence are valuable competitive. Therefore, to reconsider the status of peaks and there are new challenges to their climbing, such an example being Bloomers Challenge UK, comprising peaks with minimum prominence of 500 m.

Given these considerations, the present study aims to determine the prominence of the representative peaks of the main ridge of Rodnei Mountains, in order to highlight their value and competitiveness for tourism.

Study area

Rodnei Mountains are located in the northern group of the Eastern Carpathians, between Dragoș Vodă fault in the north, Prislop, Bistrița Aurie Valley, Rotunda Valley and Rotunda Pass to northeast, Someșul Mare Valley on the east and southeast, Rodnei fault to south, Sălăuța Valley, Șetref Pass and Carelor Valley to the west (fig. 2). The analyzed peaks are located on the main ridge, which runs sinuous between Șetref Pass (826 m) and Rotunda Pass (1277 m), showing a branching northward along the lines Rebra-Buhaescu Mare-Pietrosul Mare (fig. 3).

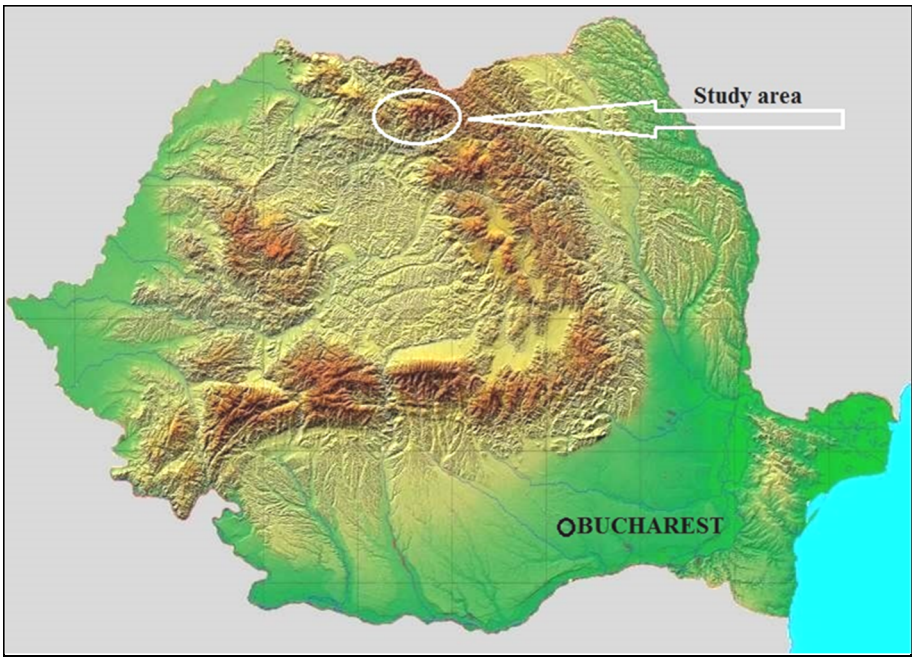

Fig. 2. The geographical position of Rodnei Mountains in Carpathians Chain

Fig. 3. The main ridge of Rodnei Mountains
(Source: mapmyhike.com, with changes)

From the geological and geo-morphological point of view, these peaks are shaped by erosion, are composed of hard rock (metamorphic rocks), resulting from the process of carving the upper (1800-2200 m), medium (1600-1800 m), and lower leveling surfaces (1100-1300 m) of Rodnei Mountains (Sîrcu, 1978; Geography of Romania, vol. I, 1983).

Materials and methods

To achieve this study we used several materials such as:

-online topographic map 1:25 000 scale, provided by the Department of Military Topography, on which we calculated manually the prominence of the main peaks;

-geological map scale 1: 200 000 (1968);

-Rodnei Mountains tourist map 1:55000 scale (2014);

-the photos taken in during the field trip;

-studies about the landforms of Carpathians and Rodnei Mountains (Sîrcu, 1978; Geography of Romania, 1983, 1987; Trif, 2014);

-studies about topographic prominence of peaks relevant to mountaineering and mountain sports (climbing, rock climbing, hiking, extreme skiing, ski touring) (Munro, 1891; Donald, 1935; Nuttall, Nuttall, 1989, 1990; Goedeke, 1991; Dawson, 1992; Graham, Fiona, Torbet, 1992; Höhne, 1993; Dewey, 1995; Dawson, 1997; Munro, Bearhop, 1997; Grimm, Mattmüller, 2004; Goedeke, 2006);

-works about the calculation of orometric prominence and dominance (Helman, 2005; Schmidt, 2018; Stubbemann et al., 2019);

-different web pages related to prominence, such as:

-http://www.peaklist.org/lists.html;

-https://explorersweb.com/2018/02/23/prominence-or-dominance-what-makes-a-mountain;

-https://www.8000ers.com/cms/en/dominance-mainmenu-178.html;

-https://routes.tips/blog/on_terminology_elevation_vs_altitude_vs_prominence;

-http://www.cohp.org/prominence/publication_2005_illustrations/Chapter_2/index.html;

-http://www.cohp.org/prominence;

-https://peakvisor.com/panorama.html?lat;

There were chosen the peaks of the main ridge of Rodnei Mountains (table 1), which, based on topographic maps, were manually calculated the prominence. Methodological steps were as follows:

a) drawing a geomorphological profile on the main ridge, by using the topographic surface of the site mapmyhike.com, outlining the sequence of peaks and saddles (fig. 4);

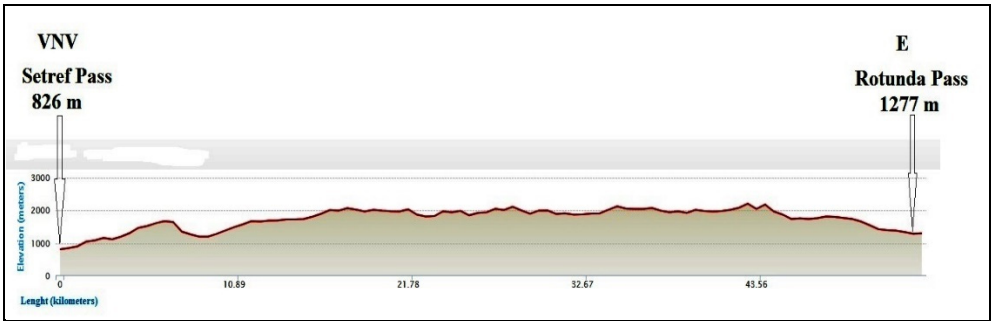

Fig. 4. The Geomorphological profile of the main ridge of Rodnei Mountains (Source: mapmyhike.com with changes)

b) schematic drawing of two sections, one for the Șetref Pass-Pietrosul Mare peak (fig. 5), and one for the main summit between Șetref Pass and Rotunda Pass (fig. 6) to observe the sequence of peaks and saddles; based on these schematic profiles, it was established the rank of the peaks, the relations of subordination between them, and key saddles for each peak; the lower ends of the ridge is Șetref Pass saddle (826 m) to the west, and Rotunda Pass saddle (1277 m) to the east, to which it relates Pietrosul Mare peak (2303 m), and Ineu peak (2279 m); inside the ridge there are numerous saddles that define peaks, and acts as key saddles;

c) manually calculating of the prominences based on online topographic maps 1: 25,000 of https://portal.geomil.ro/arcgis/home/webmap/viewer.html; the prominence of parent peak Pietrosul Mare was calculated by related it to Setref Pass (826 m), and the prominence of subpeak of rank I Ineu was calculated related to Rotunda Pass (1277 m); the prominences of the other subpeaks of rank I was calculated by comparing them to the deepest saddles of the ridge, and the prominences of the subpeaks of rank II-III were calculated by comparing them to subpeaks of rank I and to neighboring key saddles that genetic connecting these peaks, because the lower rank peaks gravitate towards higher peaks rank; 4 peaks were determined by rank I, to which revolve peaks of II and III ranks, in the 4 groups (Rebra, Puzdrele, Gărgălău and Ineu) (fig. 6);

e) noting the resulting data in the table (table 1) and determining the status of the analyzed structures: peaks or summits; adopting UIAA rules, the structures which prominence over 30 m are considered peaks, and those below this value have the status of summits.

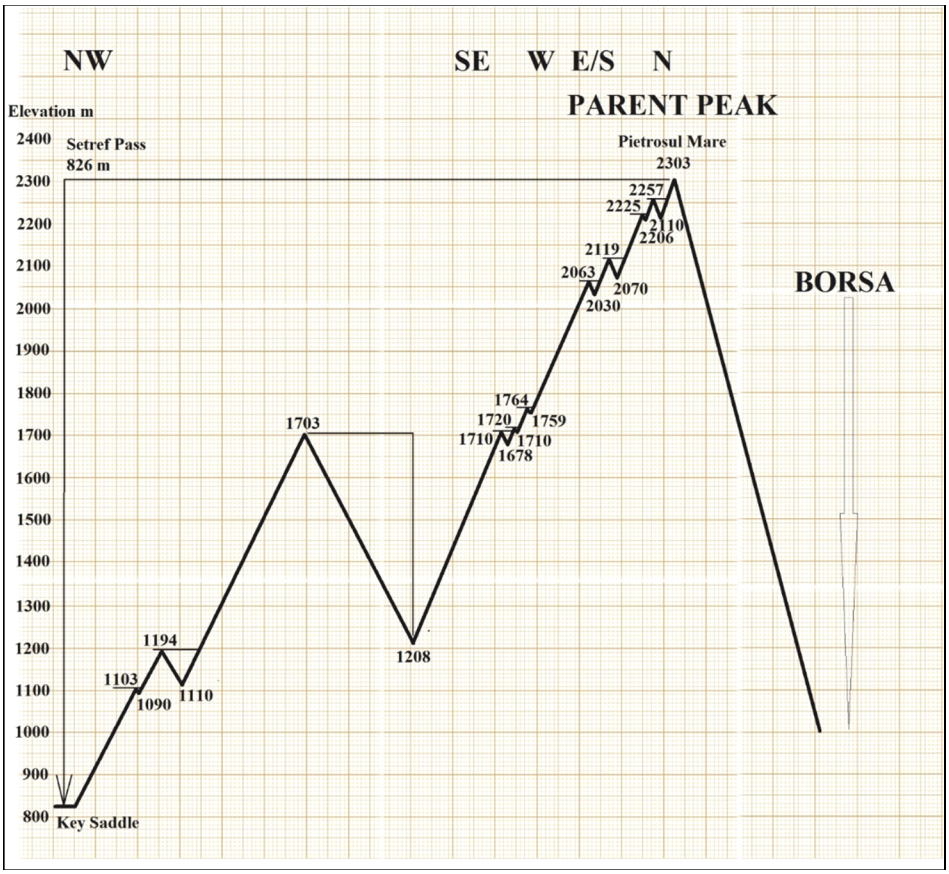

Fig. 5. Graphic of Şetref Pass-Pietrosul Mare sector illustrating the peaks and the key-saddles
(Source: https://portal.geomil.ro/arcgis/home/webmap/viewer.html)

Results and discussions

a) The peak issue

According to Online Romanian Dictionary (DEXLR), the peak is the uppermost (sharp) of tall objects (houses, trees, etc.) or of certain landforms (hill, mountain). After Oxford Advanced Learner's Dictionary, the peak is the most sharp part of a mountain, while the highest part is called summit. UIAA believes that the peak must have a prominence at least 30 m (length of climbing rope) and the height of the mountain must have a prominence of less than 300 m.

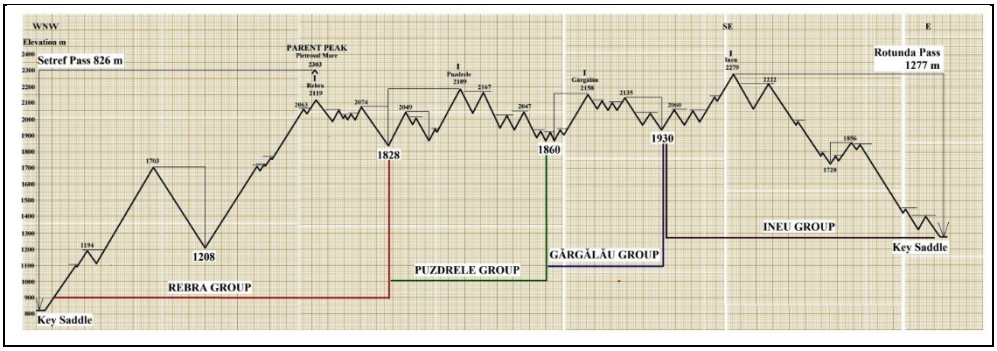

Fig. 6. Graphic of Șetref Pass-Rotunda Pass sector illustrating the rank of the peaks, the subordonation of the peaks and the key-saddles
(Source: https://portal.geomil.ro/arcgis/home/webmap/viewer.html)

Mountains and hills are distinguished, in terms of morphometric, by area, length, width, vertically extending or elevation. Vertically extending presents a high point, which is the uppermost part, called peak.

The peak is not an independent structure, but is attached to a mountain or hill, represents the highest and most obvious part of it, or the upper end thereof. It is characterized by the following features:

a) morphographic elements: base, shape, flanks, and the top (the top end, the top side); the top can be sharp, rounded, beveled or uneven / irregular;

b) morphometric elements: elevation, slopes and prominence.

The prominence is the gap between top and base of the peak. The same base is the lowest in the surrounding areas (saddles, col). The peaks of mountains are carved by erosional processes (fluvial, glacial, periglacial) that detached it from the original surface of the respectively mountain and are located at the intersection of slopes and ridges. These erosional processes operate differently, depending on the structural lines, the hardness of the rock, and the surrounding basal levels, resulting in fragmentation of the withdrawal and slopes that intersect at the point represented by the peak.

At the volcanic mountains, the peak is located in the highest part of the cone or caldera (ex. Elbrus, Damavand, Ararat, Pico Orizaba, Pietrosul Călimanilor etc.). In the folded mountains, the peak can be located at the intersection of two slopes on a residual ridge (Shishapangma Hillary Peak, Negoiu, Vânătarea lui Buteanu, Mytikas etc.) or at the intersection of at least three slopes (ex. Everest, K2, Lhotse, Annapurna, Mont Blanc, Doufurspitze, Liksamm etc.).

UIAA proposed three criteria for determining the relevance of peaks for climbing or mountaineering:

1) topographical criteria: any height at least 30 m (length of a climbing rope) level difference towards neighboring saddles can be considered peak;

2) morphological criteria: to be considered a peak, a height must have a certain shape (conical, pyramidal);

3) leisure criteria: the peak must provide access routes, cultural and historical connotations, flows of visitors.

b) The analysis of prominence of major peaks from Rodnei Mountains main ridge

The topographic map analysis established on the main ridge of Rodnei Mountains a total of 39 peaks, presenting relevant morphological characteristics for the present study (elevation, shape, microrelief) (fig.7).

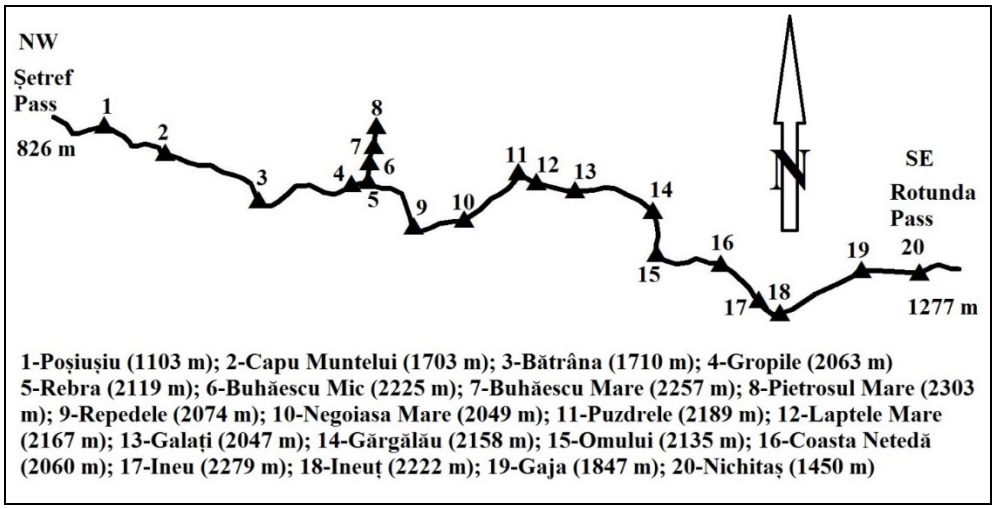

Fig. 7. The most important peaks from Main Ridge of Rodnei Mountains (Source: Online Topographic Map of Romania 1:25000 from https://portal.geomil.ro/arcgis/home/webmap/viewer.html)

After manual calculating of prominence, following data were obtained (table 1):

Table 1. The prominence and the status of peaks from main ridge of Rodnei Mountains

Crt. no.	The peak	Elevation (m)	Prominence (m)	Key saddle (m)	Status
1	Poşiuşiu	1103	13	1090	Summit
2	Făget	1194	84	1110	Peak
3	Capul Muntelui	1703	495	1208	Peak
4	Bătrâna 1	1710	32	1678	Peak
5	Bătrâna 2	1720	10	1710	Summit
6	Bătrâna 3	1764	5	1759	Summit
7	Gropile	2063	33	2030	Peak
8	Rebra	2119	49	2070	Peak
9	Buhăescu Mic	2225	19	2206	Summit
10	Buhăescu Mare	2256	146	2110	Peak
11	Pietrosul Mare	2303	1477	826	Parent peak
12	Obârşia Rebrei	2054	73	1981	Peak
13	La Cățâni	2025	23	2002	Summit
14	Cormaia	2033	43	1990	Peak
15	Repedele	2074	246	1828	Peak
16	Negoiasa Mare	2049	184	1865	Peak
17	Negoiasa Mică	2010	45	1965	Peak
18	Bârsan	1939	19	1920	Summit
19	Puzdrele 1	2167	17	2150	Summit
20	Puzdrele 2	2189	361	1828	Peak
21	Laptele Mare	2167	132	2035	Peak
18	Negoiescu	1972	32	1940	Peak
19	Galaţi	2047	117	1930	Peak
20	Cimpoiaşu	1930	50	1880	Peak
21	Piatra Rea	1922	62	1860	Peak
22	Izvorul Cailor	1945	45	1900	Peak
23	Gărgălău	2158	298	1860	Peak
24	Claia	2117	57	2060	Peak
25	Cepelor	2102	52	2050	Peak
26	Omului	2135	205	1930	Peak
27	Cişa	2039	79	1960	Peak
28	Coasta Netedă	2060	100	1960	Peak
29	Tomnatic	2051	71	1980	Peak
30	Bila	2140	30	2110	Peak
31	Ineu	2279	1002	1277	Peak
32	Ineuţ	2222	162	2060	Peak
33	Pietros	1977	17	1960	Summit
34	Curmătura Gajei 1	1798	28	1770	Summit
35	Curmătura Gajei 2	1771	31	1740	Peak
36	Dosu Gaja	1856	136	1720	Peak
37	Gaja	1847	37	1810	Peak
38	Nichitaş	1450	20	1430	Summit
39	Rotundu	1405	35	1370	Peak

Depending on the prominence, can be separated following peaks categories:

a) very high prominence peaks: over 1000 m (Pietrosu Mare, Ineu);
-these are iconic peaks, coveted by mountaineers;
-they have a rough configuration (steep flanks, glacial cirques, chimneys, ridges);

b) peaks with the largest prominence: between 200-400 m (Gărgălău, Omului, Puzdrele, Capu Muntelui);
-these are coveted by mountaineers;
-provides panoramic view;
-they have a slightly uneven configuration (rock formations on the sides, scree slopes, chimneys);

c) peaks with medium prominence: 100-200 m;
-some are coveted by the mountaineers (Coasta Netedă, Galaţi, Laptele Mare, Buhăescu Mare, Ineuţ, Negoiasa Mare);
-they have conical shape and slightly uneven configuration (rocky slopes, chimneys, ridges);

d) peaks with low prominence: 30-100 m;
-they are not very coveted by mountaineers, possibly for scenic view;
-they have beveled configuration (Obârşia Rebri, Cormaia, Negoiasa Mică, Cişa), conical and sharp configuration (Rebra, Claia), narrow and elongated configuration (Tomnatic, Bila), or rocky configuration (Gropile, Cepele);

e) summits: prominence under 30 m (Poşiuşiu, Bătrâna 2 and 3, Buhăescu Mic, La Căţâni, Bârsan, Puzdrele 1, Pietros, Curmătura 1, Nichitaş).

Based on prominence and elevation, it was established the orometric dominance of each peak. This parameter was introduced in 2004 by Peter Grimm and Claus Roderich Mattmüller, and shows the percentage of independence of a peak, regardless of altitude and prominence. It is calculated as P / Alt x 100 (table 2).

Depending on the orometric dominance, established following peaks categories:

-supreme peaks: OD = 43.96-64.13 (Pietrosul Mare, Ineu);
-dominant peaks: OD = 11.86-29.06 (Capu Muntelui, Repedele, Gărgălău, Puzdrele);
-major peaks: OD = 5.71-9.60 (Galaţi, Laptele Mare, Buhăescu Mare, Făget, Ineuţ, Dosu Gaja, Negoiasa Mare, Omului);
-regular peaks: OD = 1.40-4.85.

Table 2. The orometric dominance of the peaks from main ridge of Rodnei Mountains

Crt. no.	Peak	Elevation (m)	Prominence (m)	Dominance (m)
1	Făget	1194	84	7,03
2	Capul Muntelui	1703	495	29,06
3	Bătrâna 1	1710	32	1,87
4	Gropile	2063	33	1,59
5	Rebra	2119	49	2,31
6	Buhăescu Mare	2256	146	6,47
7	Pietrosul Mare	2303	1477	64,13
8	Obârşia Rebrei	2054	73	3,55
9	Cormaia	2033	43	2,11
10	Repedele	2074	246	11,86
11	Negoiasa Mare	2049	184	8,97
12	Negoiasa Mică	2010	45	2,23
13	Puzdrele	2189	361	16,49
14	Laptele Mare	2167	132	6,09
15	Negoiescu	1972	32	1,62
16	Galaţi	2047	117	5,71
17	Cimpoiaşu	1930	50	2,59
18	Piatra Rea	1922	62	3,22
19	Izvorul Cailor	1945	45	2,31
20	Gărgălău	2158	298	13,80
21	Claia	2117	57	2,69
22	Cepelor	2102	52	2,47
23	Omului	2135	205	9,60
24	Cişa	2039	79	3,87
25	Coasta Netedă	2060	100	4,85
26	Tomnatic	2051	71	3,46
27	Bila	2140	30	1,40
28	Ineu	2279	1002	43,96
29	Ineuţ	2222	162	7,29
30	Curmătura Gajei 2	1771	31	1,75
31	Dosu Gaja	1856	136	7,32
32	Gaja	1847	37	2,00
33	Rotundu	1405	35	2,49

c) Tourist relevance of orometric prominence

Following the manual calculation of the prominence, on the main ridge of Rodnei Mountains have revealed some geomorphological structures with peaks status (P=over 30 meters) and summit status (P = less than 30 m) (fig. 8).

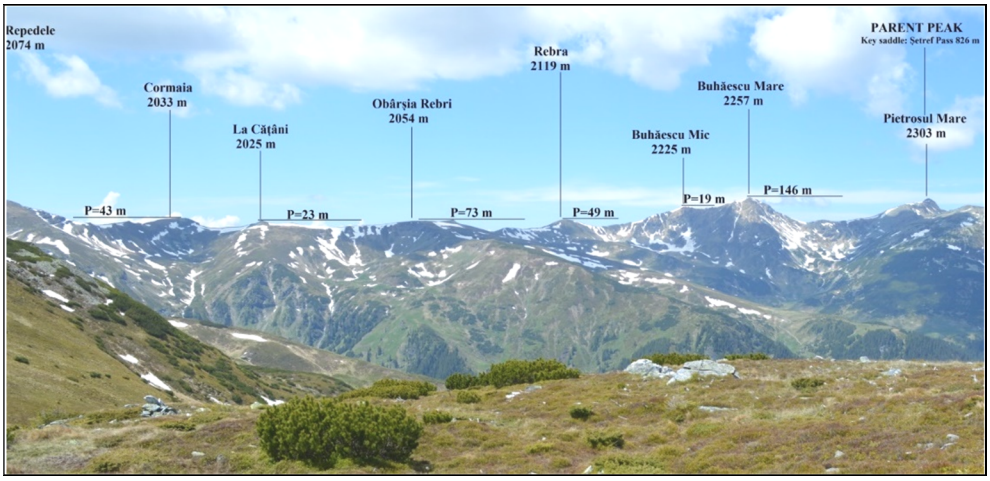

Fig. 7. The Main Ridge of Rodnei Mountains. Repedele-Pietrosul Mare sector showing elevation and prominence of the peaks

Peaks have competitive value for mountaineers, and by altitude, prominence, shape and microrelief are attractions for practicing hiking, scrambling, ecotourism, mountain biking, running and ski touring (table 3).

Table 3. The number of tourists and visitors in Rodnei Mountains National Park (2019)

Tourist season	Days number/year	Average number of tourists/day	Total tourists/season
Full season (July-August)	60	300	18000
Transition season (May-June, September-October)	120	70	8400
Extra-season (November-April)	185	10	1850
Total number of tourists/year	365	380	28250

Source: Rodnei Mountains National Park Office

Based on these aspects and according to mountaineering flows, on the main ridge of Rodnei Mountains stand out following peaks of major interest:

1) Pietrosul Mare (2303m):
   -access from Borşa (80%);
   -access from other directions (20%);
2) Ineu (2279 m):
   -access by Lala Valley (30%);
   -access from Alpina Blazna Resort (40%);
   -access from Rotunda Pass (20%);
   -access from other directions (10%);
3) Gărgălău (2158 m):
   -access from Borşa (40%);
   -access from Prislop Pass (30%);
   -access from other directions (30%).

Conclusions

After the calculations made during this study, on the main ridge of Rodnei Mountains, there are two categories of geomorphological structures: peaks (P = over 30 meters) and summits (P = less than 30 m). The peaks are attractions for hiking enthusiasts, and those showing high prominence are highly competitive, and are escalated for performance, because during this sport activity there are many physical and technical demands.

From methodological perspective, this study sets out the steps leading to the process of manual calculation of the peaks prominence, such as: analysis of topographic map, creating a geomorphological profile, and the diagram/graphic to bring out the peaks in a particular sector, the setting of the rank of the peaks, the subordination relations between the peaks, and the key saddles.

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