*Available online a*t www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2012, 3 (6):3970-3980

ISSN: 0976-8610
CODEN (USA): AASRFC

Types of glacial landforms on Capra Valley (The Fagaras Mountains-Romania)

Alexandru Nedelea and Laura Comanescu

Bucharest University, Faculty of Geography, Geomorphology-Pedology Department, 010041. No 1. N. Balcescu Avenue, Bucharest, Roumania

---

ABSTRACT

The glacial shaping of mountain areas is accomplished by two processes: exaration (glacial erosion), which produces a series of specific landforms – cirques, glacial troughs, thresholds, shoulders, sheepback rocks, arêtes, saddles etc., and accumulation, which is responsible for moraine formation. Investigations have proven that in Romania the glaciers developed on the torrential catchments lying at the edge of the Borascu planation surface. During the first glacial stage, torrential erosion gradually gave way to the glacial erosion, inasmuch as the abundant snowfalls had led to glacier formation. Under those circumstances, torrential catchments were turned into glacial cirques, while stream valleys became glacial troughs. During interglacial phases, stream erosion returned, but only to cease again with the next glacial stage. The glacial cirques are the main forms of glacial erosion that have survived up to the present. As a matter of fact, they are an irrefutable argument in favor of the existence of a glacial climate in the Fagaras Mts.

Key words: Capra valley, glacial processes, glacier cirque, glacier valley, moraines, Fagaras Mountains, Romania.

INTRODUCTION

The glacial shaping acted relatively different at regional and local level depending on the glacial stages, the dissection degree of the periglacial landforms, terrain exposure to the prevailing winds, gradient, elevation, geological structure and lithology. Consequently, over the time, the Fagaras Mts. sheltered the following types of glaciers [1, 2]:

- *Valley glaciers*, characterized by large catchment areas, with two or three secondary lobes, and glacial tongues that created typical U-shaped valleys, 6 to 8 km long, which descended as low as 1300 – 1400 m (for instance Buda, Capra and Museteica valleys) [1];
- *Cirque glaciers*, having no tongues at all or exhibiting very short ones, which occurred at about 2400 – 2500 m altitude on the brim of the more complex cirques (for instance the hanging cirques beneath the Vartopu-Buda-Raiosu-Museteica ridge, belonging to the Capra glacial complex) [1];
- *Plateau glaciers*, which found proper development conditions on the planation surfaces lying at elevations above 2000 m. In the Fagaras Mts., this type of glaciers was found on the Paltinu plateau. However, there are scientists who doubt that such glaciers could have existed in the past in the Fagaras Mts. For instance, according to Posea what many scientists consider to have been plateau glaciers were in fact only hanging glaciers of larger dimensions [1, 3].

For the Romanian territory in general and for the Fagaras Mts. in particular the Quaternary era meant a change of the land-shaping system. The large development of the glaciers in the Southern Carpathians explains why the first studies on the Quaternary glacial phenomena occurred in these mountains.

The first geographical works belong to P. Lehman (1880 – 1885), who revealed and interpreted for the first time the cirques, tarns and moraine deposits in the Fagaras Mts. Although its theory was challenged, Lehman continued his researches in the area of the Sureanu, Retezat and Parang mountains, bringing new evidence on the existence of glacial landforms in other massifs, too [1].

At the end of the 19th century, the writings of some geologists and geographers like L. Mrazec, Gh. Murgoci and V. Popovici came to support the theory of the existence of glacial landforms in the Southern Carpathians.

The period from 1900 to 1912 was dominated by the studies of Emm. de Martonne, who synthesized his findings in the work entitled „*Recherche sur l'evolution morfologique des Alpes des Transilvanie*" (1907), which would become a landmark for many future studies. De Martonne turned its attention to the Parang Mts., where he mapped the glacial cirques and moraines and made observations on the glacial troughs, shoulders, thresholds, grooves and sheep-back rocks, finally coming up with a map of the glacial topography. At the same time, de Martonne made appreciations on the extension of the glaciers and on the position of the permanent snow line, inferring from his observations the existence of two glacial phases (Riss and Würm). With the exception of the studies of L. Loczy (1903) and L. Sawicki (1912), until 1929 the interest for studying the traces of the glacial ages in the Southern Carpathians dropped [1].

Later on, the number of researchers who turned their attention on this topic grew. From among them, we should mention Th. Krautner (1929), who tried to accomplish a new descriptive synthesis on the glacial morphology of the entire Carpathian arc, S. Pawlowski (1934), who considered that within the Carpathian realm the glaciers developed on distinct massifs, separated by deep valleys, D. Burileanu (1941), who made observations on the geological structure and the topography of Southern Carpathians, as well as H. Wachner, L. Somesan, T. Morariu and others.

A new stage in the study of the Carpathian glacial age began in 1954, with the investigations meant to contribute to the accomplishment of the Geographical Monograph of the People's Republic of Romania. The most important studies of this period were those of Silvia Iancu (1958), who analyzed the influence of structure and lithology on the glacial morphology of the Parang Mts.; E. Nedelcu (1958 – 1962), who turned his attention to the Fagaras and Iezer mountains; V. Michalevich-Velcea (1961), who studied the Bucegi Mts.; Gh. Niculescu (1957, 1965, 1969, 1971), who investigated the Tarcu-Godeanu, Retezat, Sureanu and Cindrel massifs; I. Sarcu and V. Sficlea (1958), who tried to make a new presentation of the glacial morphology of the Parang and Sureanu massifs; I. Sarcu (1963, 1969), who analyzed the Rodna and Maramures mountains; and T. Naum (1970), who focused on the Calimani massif [1].

In 1981, Gr. Posea examined the Capra glacial trough and after thorough investigations launched the hypothesis that in the past the Carpathians had been affected only by the Würm glacial phase. To support his theory he explained that the valley shoulders flanking the Capra valley have a periglacial origin, thus refuting the theory that considered them as an evidence of the glacial erosion. This hypothesis was also supported by M. Carciumaru, who argued that the Würm glacial age had been the most important for the Romanian territory. He also asserted that during that period the physical weathering had been so intense that any potential evidence of the previous glacial ages had been wiped out .
In order to establish as accurately as possible the extension of glacial and interglacial phases, the specialists relied on evidence not only from the mountain realm, but also from the depressions lying on the mountain edges, where correlated deposits occur. Thus, N. Popescu (1990) noticed in the Fagaras Depression a higher level of argillization of the sediments overlying the gravel of the upper piedmontane glacis, which led him to infer the existence of one or several glacial stages. Likewise, P. Urdea (1993) holds the existence of Riss and Würm glacial stages, based on an indirect dating of the moraine deposits in the Retezat Mts [1]

From the works reviewed so far, we may derive some important conclusions, as follows:

- most researchers place the permanent snow line at 1900 m in the Southern Carpathians, 1550 – 1900 m in the Rodna Mts. (L. Sawicki 1911, I. Sarcu 1969), 1500 m in the Maramures Mts., 1700 m in the Calimani massif (L. Sawicki, 1912) and 1800 m in the Sureanu and Cindrel massifs [4]. As far as the Fagaras Mts. are concerned, Emmanuel de Martonne thought that the snow line had been lying at 2100 m;
- the development of the glacial cirques and troughs on the slopes facing to the north and northeast made some researchers believe the prevailing winds had been blowing from east or northeast (Emm. de Martonne, 1904; T. Krautner, 1929), bringing high amounts of precipitation, which supported the glaciers growing. On the other hand, there were also specialists who thought the prevailing winds had been blowing from west or southwest, which would determine the accumulation of high amounts of snow on the leeward slopes[1];
- as far as the number of glacial phases is concerned, most researchers (Emm de Martonne, 1907, T. Krautner, 1929, Gh. Niculescu, E. Nedelcu, Silvia Iancu, 1960, Valeria Velcea, 1961, Urdea, 1993 etc.) argue the existence of

two glacial phases (probably Riss and Würm) in the Southern Carpathians. However, Sawicki (1912) and Sârcu (1969), hold that the Carpathians were affected by three glacial phases beginning with Mindel or Riss, but because the two researchers analyzed only the position of the moraines within the valley without dating them, their arguments are debatable[1].

MATERIALS AND METHODS

We used several methods like: geomorphological mapping, study of aerial photographs, sedimentologic and petrographic methods.

Field works were accomplished in several research campaigns, in which we made use of topographic surveys of scale 1:5000, topographic maps of scales 1:25000 and 1:50000, geological maps of scale 1:50000 and geological reports, which included sketches of scale 1:25000. We made an inventory of the landforms and deposits encountered in the field, and mapped them all by using a morphogenetic legend to which we added a series of symbols (directions of the glacial grooves, rock circles and so forth).

The study of **aerial photographs and satellite imagery** was another research method, which proved to be extremely useful and interesting. By watching stereoscopic photographs showing parts of the main ridge of the Fagaras Mts., we were able to spot the study landforms, to map the inaccessible ones and to plan the field investigations.

The sedimentologic methods (petrographic, granulometric and morphometric) were very helpful for understanding the genesis of the glacial, periglacial and fluvial deposits.

The petrographic study of round cobbles, talus slopes and moraine deposits allowed us to establish the origin of various rocks.

RESULTS AND DISCUSSION

The morphology of the glacial cirques and valleys belonging to the Capra complex

1.1. The Capra glacial complex

The types and shapes of the glacial cirques and valleys are directly influenced by tectonics, geological structure, petrography, elevation, glacier dynamics and the pre-existing topography [5]. In the cross profile they all resemble the shape of letter U and exhibit two or three glacial thresholds with noteworthy lithological and structural features. The big number of cirques and valley floors is the result of a long shaping period, in which the glacial, but mostly the Pleistocene periglacial processes, played a significant part.

The Capra glacial complex (fig. 1) includes several cirques, which feed the Capra valley, as follows:

- *the Capra cirque*, towered to the southwest by the Iezerul Caprei (2417 m), to the north by the Vaiuga peak (2443 m) and to the northeast by the Vanatoarea lui Buteanu peak (2517 m), which shelters the Capra and Caprita tarns;
- *the Fundul Caprei cirques* (one in the east and the other in the west), lying at the headwaters of the Capra valley. To the southeast, they are towered by the Arpasu Mic or Vartopu peak (2460 m), while to the north are closed by the main ridge of the Fagaras Mts, more exactly the section developing between the Arpasel arête and the *Zmeilor window*. The two cirques are separated from the Capra cirque by an extension of the ridge that stems to the south from the Vanatoarea lui Buteanu peak;
- *the small corries of Paltinu and Caltun*, towered to the west by the Lespezi, Laita and Laitel summits and to the north by the Paltinu peak, which rises above the main ridge that separates the corries from the Balea cirque.

The Capra cirque and its glacial trough are separated from the neighboring Balea cirque by the Capra saddle. At the same time, they are flanked to the north-northwest by the Vanatoarea lui Buteanu, Vaiuga and Capra peaks and to the east by the Piciorul lui Buteanu ridge, which separates them from the Fundul Caprei valley. The slopes of the Capra glacial cirque are affected by intense physical weathering (fig. 2), which explains the talus accumulations lying at their foot (talus cones and aprons, rock streams etc.).

On the cirque floor, one can see the Capra (2230 m) and Caprita (2229) tarns, connected by a 10 m long brook. The cirque develops on micaschists, while the glacial threshold lying in front of it is underlain by limestones. Here, one can see a protalus rampart, 1 or 2 m high, and several nival niches, which may shelter patches of snow from year to year. Often, these niches are covered by scree. The presence of mobile screes highlights the intense gelifraction processes affecting the micaschists, while the existence of the few nival depressions is illustrative for the nivation effectiveness. In the cross profile, both the valley and the cirque are U-shaped and show many glacial and periglacial shoulders. At the same time, one can note that slopes have a significant recession tendency, which can be put to the account of the periglacial conditions. In the long profile, the valley proves to be consequent and exhibits three glacial thresholds.

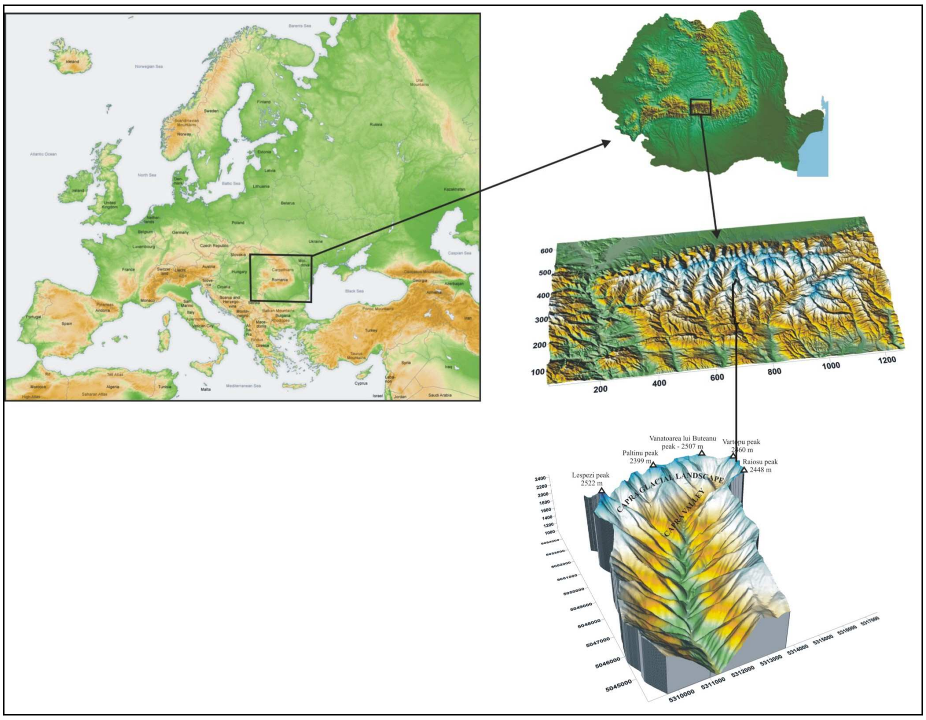

Fig. 1 The geographical position of Capra Valley. The glacio-nival and torrential stretches of the Capra valley

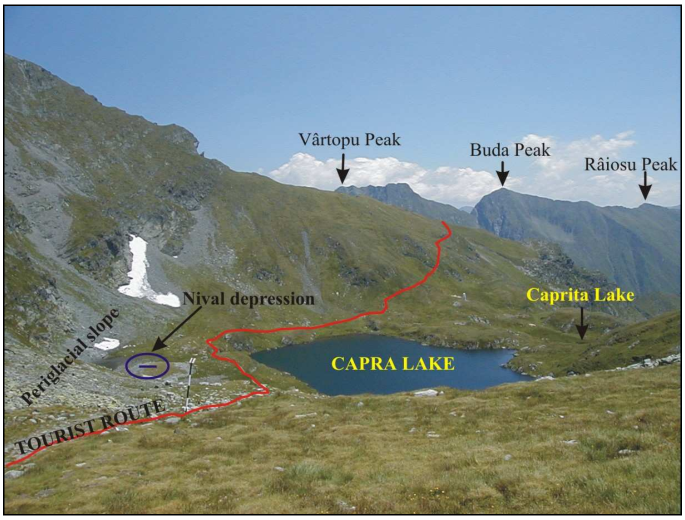

Fig. 2 The Capra-Caprita glacial complex

On the first one, lying downstream the two lakes, there are sheepback rocks covered by stabilized screes and grassy vegetation. The second step shelters many lacustrine depressions, silted and turned into peat bogs, which occasionally may develop into small lakes, especially in springtime. The last glacial threshold is found in front of the Berbecilor cirque. It develops on amphibolites and represents in fact the slope of the main valley. On this level, one can see a spectacular waterfall (fig. 3), more than 35 m high.

This section of the Capra glacial trough suffered an intense anthropogenic alteration during the construction of the Transfagarasan [6] road and of the tunnel ensuring the connection between the southern and northern slopes of the Fagaras massif.

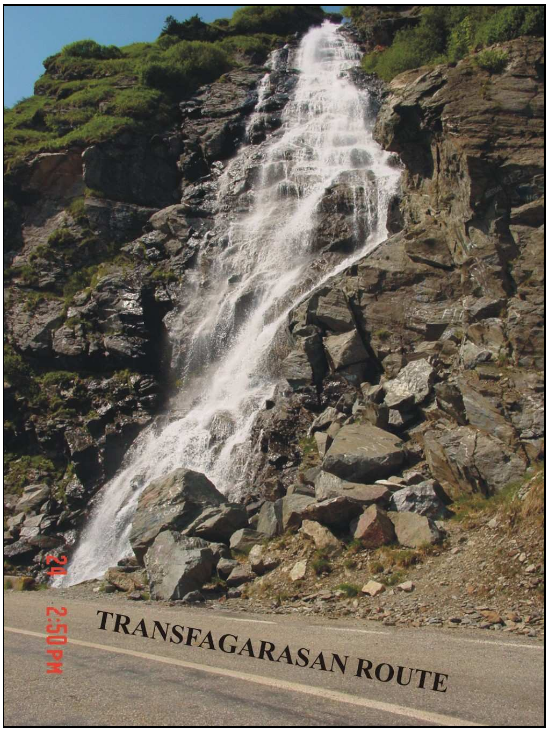

Fig. 3 The Capra waterfall developed on a glacial threshold

3.2.The Fundul Caprei glacial valley

This valley develops on the headwaters of the Capra trough, being closed to the north by the Arpasel ridge, which is strongly affected by gelifraction (fig. 4).

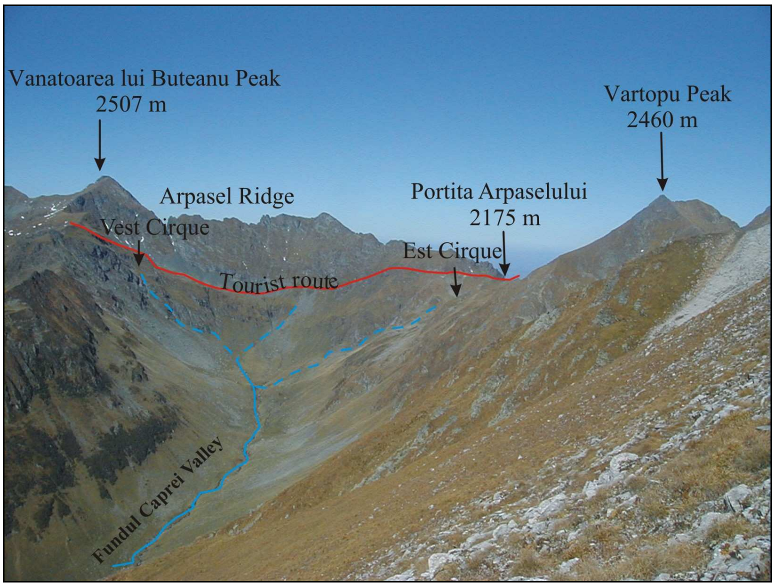

Fig. 4 The Fundul Caprei glacial trough seen from the Raiosu peak

It is carved in micaschists with amphibolites intercalations, quartzitic schists and crystalline limestones. The cirque it originates from has two lobes, a hanging one to the west, closed by dynamic slopes and ridges (which generate significant amounts of debris), and another one to the east, flanked by the Vartopu peak and the Portita Arpaselului saddle [7]. On the cirque floor, there are scree accumulations, which preserve interstitial ice (rock glaciers); on the slopes of these cirques, as well as on the Arpaselului ridge, avalanches are a common phenomenon.

In the cross profile, the valley shows two levels of glacial shoulders. At the same time, one can note the presence of two superposed valleys (one larger and older, and the other one narrower and younger), which represent an important evidence in favor of the hypothesis of the occurrence of two glacial phases. In addition, one can distinguish three alignments of terminal moraines lying at 1550 m (near the Capra chalet), 1480 m (in the vicinity of the Capra sheepfold) and 1370 m (fig. 5).

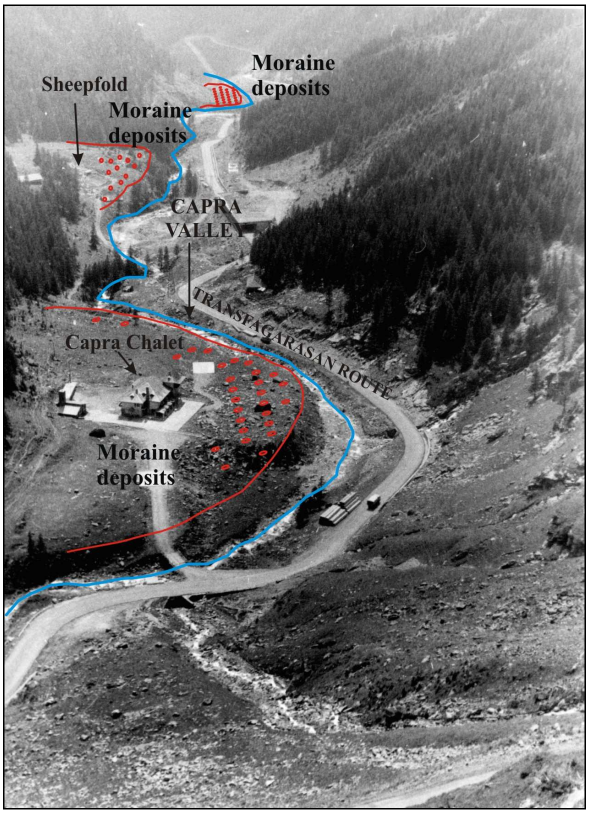

Fig. 5 Moraine deposits impacted by anthropogenic activities and detritus fallen from the slopes within the Capra valley

In the long profile, the valley displays a sequence of depressionary areas and thresholds, which alter its orientation: from the initial north – south one, to an east – west orientation and finally to a northeast – southwest one.

3.3.The hanging cirques

On the left side of the Capra valley, at elevations between 1900 and 2200 m, there are about nine hanging cirques of Pyrenean type placed one above the other [3], which are generally carved into the calcareous bar of the Buda-Raiosu-Museteica-Mesteacanu ridge. Their slopes are well developed and their features are influenced by the structure. These cirques are lying at the headwaters of the torrential catchments that drain and dissect the left slope of the Capra valley as low as 1300 m altitude, and even lower. They shelter high amounts of gelifracts and are strongly influenced by the contemporary geomorphological processes (nivation, raindrop impact, rill erosion and torrentiality). During the glacial phases, they fed with ice the main valley (fig. 6).

3.4. The Caltun-Caprioara cirque and its glacial trough

The Caltun cirque is bounded to the east by the Portita Negoiului saddle, to the south by the Lespezi ridge and the Lespezi peak (2522 m), and to the north by the Laitel ridge (2391 m), which separates it from the Laita glacial trough. The cirque is oriented on a west – east direction and is carved in faulted micaschists, amphibolites and gneisses, the strata of which dip to the north and northeast, conferring it a subsequent character. The flanking walls are asymmetric, the right one being steeper and resting on amphibolites, while the left one is less inclined, but higher, having small cliff sections [8]. On the cirque floor, one can see the Caltun tarn, whose circular shape can be explained by the amphibolites underlying it, which are rather hard rocks, resistant to erosion (fig. 7).

The whole Caltun cirque is covered by scree aprons and fields, made up of big size gelifracts, which preserve interstitial ice all year round. As far as the periglacial processes are concerned, these are represented by gelivation and nivation.

In front of the glacial threshold lying at 2120 m altitude, on the right slope of the glacial valley, patches of snow persist years on end on the bottom of a north-facing nival depression. Yet, within the proper cirque, the wind blows away the snow thus preventing it to last from year to year. In the upper part of the cirque avalanche chutes are common. The ridge that flanks the cirque to the south shows two horns higher than 2500 m (Lespezi – 2522 m and Caltun – 2517 m) and a transfluence saddle (Portita Caltun) separating the Caltun and Negoiu cirques.

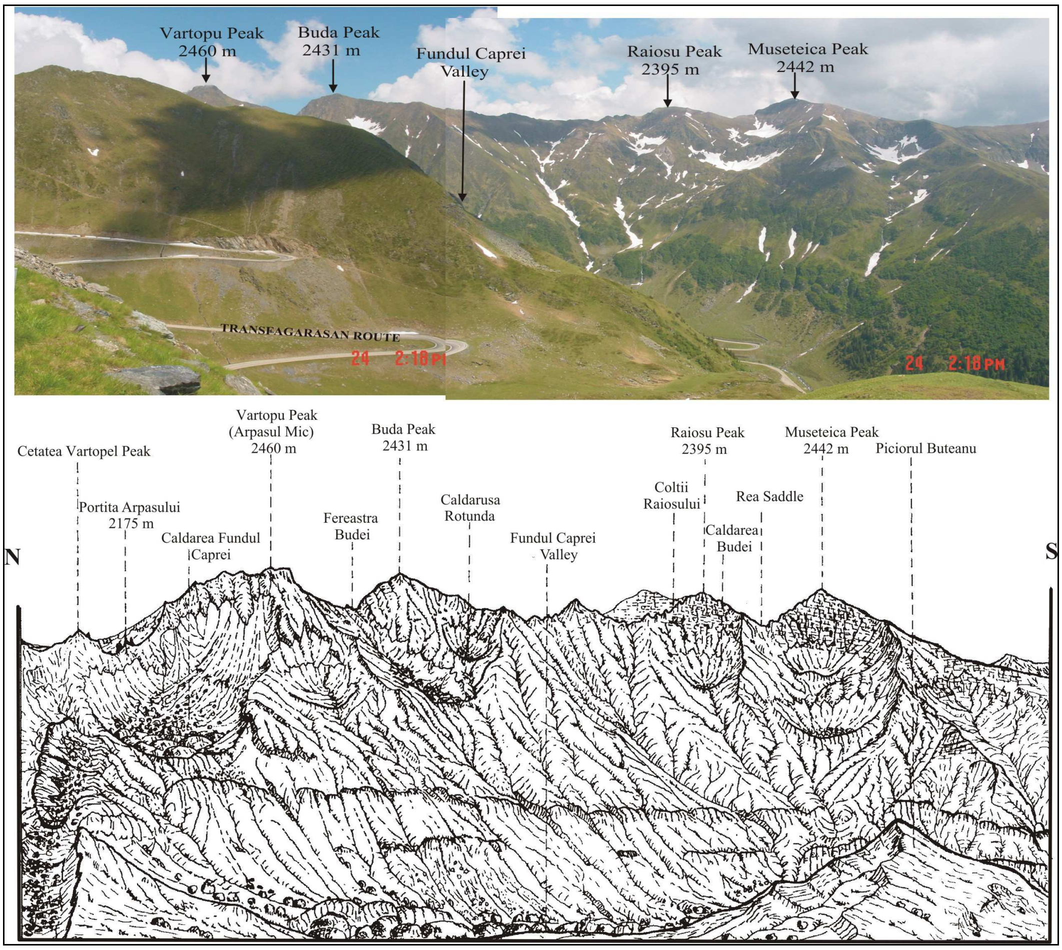

Fig. 6 Panoramic sketch of Mount Vartopu-Museteica and the adjacent hanging cirques
(taken from [9] **with modifications)**

A secondary, southeast-facing corrie can be seen below the Caltun cirque, south of the Laitel summit, at 1840 – 1900 m altitude. Less preserved because of the erosion, it shelters high amounts of detritus fallen from the slopes (probably even moraines) and ephemeral lakes formed by snow melting.

In the area where the Caltun glacial trough makes a tight meander and becomes a consequent valley, one can see a glacial-nival cirque. Its slopes, interrupted by steep sections, are covered by scree aprons stabilized by juniper tree forests. On the right side of the Caltun valley lies a small and quasi-circular consequent hanging cirque, which impresses through the asymmetry of its slopes. Its small size can be explained on the one hand by the gentle gradients of the geological strata and on the other hand, by the lack of fractures, which prevented the snow from accumulating in high amounts on the dip slope. At the upper part of the cirques, there are nival depressions and avalanche chutes.

The two consequent glacial troughs of the Caltun and Caprioara join into a single valley as soon as the Caltun trough goes past the glacial-structural threshold covered by juniper trees, green alders and rowan trees, lying at 1500 – 1600 m altitude. The Caltun valley preserves its U-shape even beyond this junction, as low as 1300 m altitude, where the consequent trough ends abruptly above the Capra stream valley, from which is separated by a petrographic scarp. In other words, in relation with the Capra valley the Caltun-Caprioara trough is nothing else but a hanging valley. Near their junction, upstream the Piscul Negru monastery, the latter crosses a calcareous bar in which has carved a short narrow gorge.

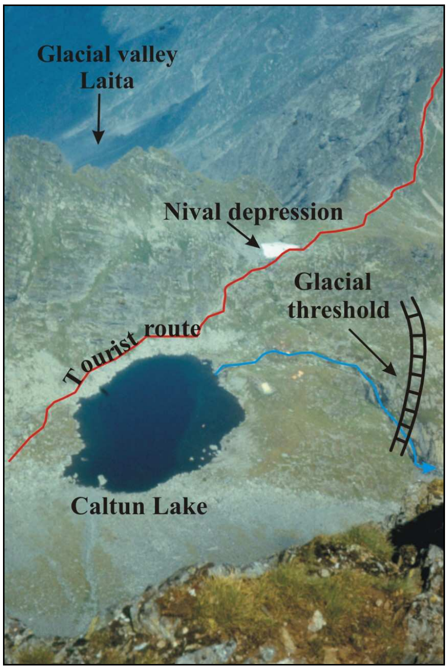

Fig. 7 The Caltun cirque and its trough seen from the Lespezi summit (2522 m)

3.5. The Paltinu cirque and its glacial trough

Known by the locals as the Caldarea Lunga, the cirque lies on the headwater area, immediately below the Paltinu peak, which has a distinctive cuesta appearance [10]. The subsequent and elongated corrie, parallel with the ridge and oriented eastwards, has developed in the area where the faults of the Negoiu system intersect. At present, both the Paltinu cirque and the valley bearing the same name are affected by intense mechanical weathering , gelifraction and erosion (along the avalanche chutes), processes often intensified by the anthropogenic activities carried out in the area (the traffic along the Transfagarasan road, overgrazing).

On slopes, there are many scree accumulations, which have encouraged the formation of nival niches. About two-thirds of the declivities devoid of vegetation are affected by gelifraction. On the cirque floor, one can see nival microdepressions and two small tarns fed by torrential valleys, which are subjected to intense silting. However, the glacial cirque is well defined and shelters a small glacial lake fed by snow melting and rainfalls. The Paltinu cirque and its corresponding valley are separated from the Caldarea Mare a Paltinului corrie and the Caprioara valley by the Piciorul Paltinului ridge and from the Capra cirque and its glacial valley by the Piciorul Iezerul Caprei ridge.

The glacial valley has four thresholds: one at the contact between the cirque and the trough, another above the tunnel, a third one occurring downstream the moraine deposit lying at 1770 m altitude and the last one situated at the end of the Capra trough. The lower stretch of the valley displays less inclined slopes, covered by pastures and affected by solifluctions, small size superficial landslides and sheep tracks.

Below the Paltinu summit (2399 m) stretches out the Paltinu plateau, a slightly structural and quasi-horizontal surface, shaped during the Pleistocene by an old plateau glacier [4, 11]. The contemporary shaping is dominated by nivation, solifluction, sheet erosion and earth hummock formation (fig. 8).

South of the Paltinu summit, the weathered materials detached from the low cliffs move down through periglacial sliding along a grassy talus slope [11]. Judging from its position and appearance it is obvious that the Paltinu peak functioned during the glacial phases as a nunatak, which confirms the hypothesis that plateau glaciers did exist in the past in the Fagaras massif.

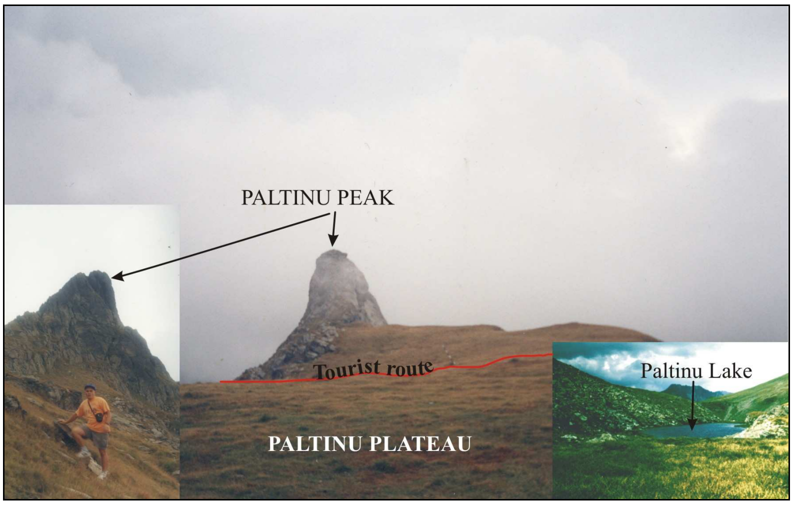

Fig. 8 The Paltinu glacial plateau

CONCLUSION

Depending on the regions where they occur and have been studied glacial cirques are known in the literature under different names: *corrie* (in Scotland), *kar* (in Germany), *nisch* (in Sweden), *caldari* or *zanoage* (in Romania) etc. All these terms designate semicircular depressions towered by steep walls, generally having a flat or gently inclined floor, which may shelter one or more lakes. Downstream, they often end with a glacial lip or threshold, a sort of counter-slope lying in front of the cirque. In the cold ages, these hollows encouraged the accumulation of snow, which eventually turned into ice. In the cross profile, all cirques are U-shaped, while in the long profile they may show several steps (fig. 9).

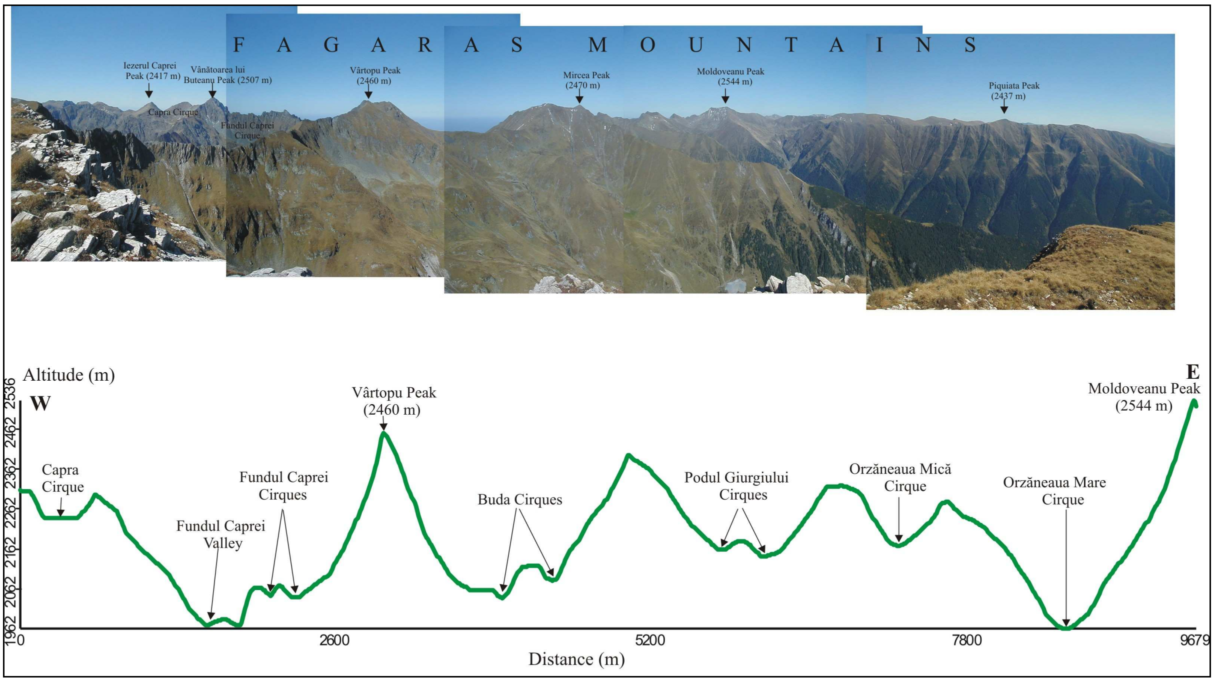

Fig. 9 Cross profile through the southern glacial cirques, between the Capra (2417 m) and Moldoveanu (2544 m) peaks

The glacial cirques in the Fagaras Mts. show different specific features depending on the structural and lithological influences, the amount of precipitation, the direction of prevailing winds and the configuration of periglacial topography. Consequently, one may distinguish here *simple cirques*, rather small and irregular, *elongated cirques*, making the connection between the proper cirques and their glacial valleys (for instance Museteica, Robita and Podul Giurgiului), *complex cirques*, with two or more lobes (Buda, Capra, Caprioara and Orzaneaua), and *glacio-nival cirques*, wide open, filled with rocks, having no thresholds and only slightly visible slopes. The latter were carved by the snow piled up on the catchments of the torrential valleys.

The glacial troughs, 2 to 8 km long**,** are well represented. In the long profile, they exhibit two or three glacial-structural thresholds, covered by peat bogs or marshes that replaced the former glacial lakes [12]. The cross profile is U-shaped and shows hanging glaciers and levels of shoulders. Generally, all troughs end with a threshold marking the contact with the periglacial realm. Under the influence of tectonics, structure and lithology glacial valleys acquired various features on the basis of which can be grouped as follows: *longitudinal valleys*, overlapping a tectonic corridor, *mixed valleys*, having transversal stretches as well, and *consequent*, *subsequent and obsequent valleys*, which develop on various geological structures [1].

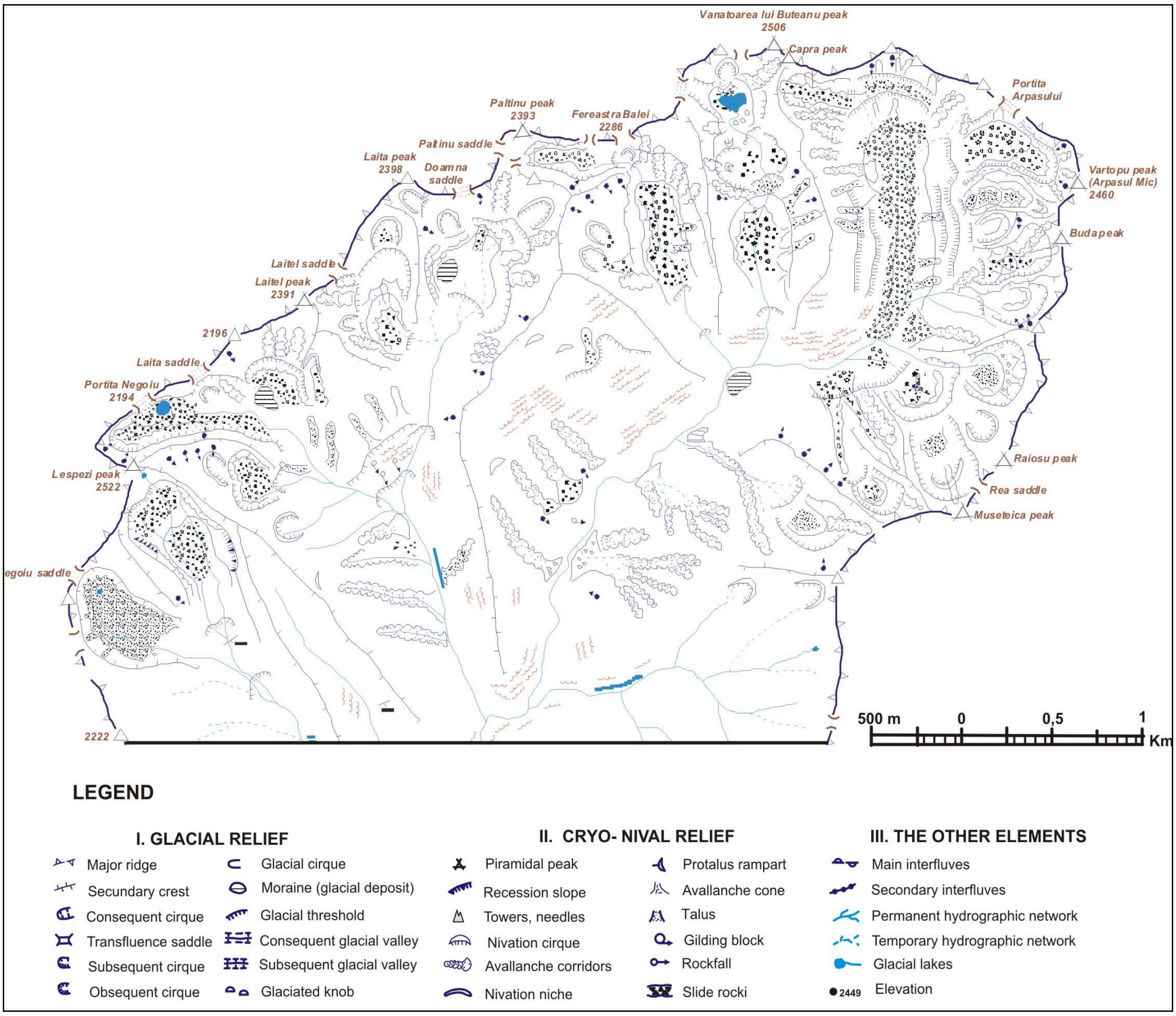

Fig. 10 The Capra catchment – the map of glacial and cryo-nival landforms

The minor landforms shaped the by glacial erosion within the cirques and valleys are represented by the *glacial steps and thresholds* imposed by structure and lithology. Their relative altitude ranges from several meters to 100 – 150 m, in the case of terminal ones, which delimit the glacial realm from the periglacial one. Consequently, terminal thresholds have a very active dynamics. The glacial shoulders occur in the long profile of the troughs. According to [3], they have a periglacial origin and came into existence due to the periglacial recession of the slopes that towered the glacial tongues. The *sheepback rocks* (asymmetrical landforms with irregular gradients) and the glacial scratches (traces left behind by the moving ice), can provide us useful information regarding the ice flow, even though with the passing of time most of them have been covered by scree, soil and vegetation. The *arêtes and transfluence saddles* are specific for the high areas, where the development of the cirques has turned the interfluves into narrow, sharp and indented ridges [13]. A very important part in the formation of these knife-edge ridges (called *karlings* in the Alps) has been played by the glacial and cryonival processes. Along the main and secondary ridges glacial and periglacial erosion have created saddles of various sizes, locally known as *portite* (gates) or *ferestre* (windows*)* (fig.10).

Those that allowed the ice to move between adjacent cirques are called *transfluence saddles* and they represent a rather common feature of the Fagaras Mts. (for instance Capra, Caltun, Negoiu, Balea, Arpas and Podragu saddles).
The accumulation landforms made up either of the detritic materials detached by the flowing ice from the valley bed and the lateral walls or of the gelifracts fallen on the glacial tongue, are represented in the landscape by the *moraines.* These came into existence when the glaciers melted away leaving behind the materials they were carrying. However, moraines are hard to be noticed along the troughs in the Fagaras Mts., because the intensity of contemporary geomorphological processes has displaced them to lower altitudes. But even so, several terminal, lateral, medial and bottom moraines can clearly be seen even today. Within the Capra and Buda glacial complexes, terminal moraines have been spotted at 1400 m altitude and, according to some geomorphologists, even lower. Apart from the moraines, other forms of deposits are the allochtonous erratic blocks, usually several meters in diameter, but occasionally reaching more than 10 m, which were carried by the glaciers very long distances. Such blocks can be seen at the junction between the Orzaneaua and Izvorul Moldoveanului troughs. The materials accumulated on the Capra valley, upstream and downstream of the first protection roof of the Transfagarasan road (1200 – 1400 m), as well as those lying within the Buda catchment, at the junctions between the Orzaneaua and the Izvorul Moldoveanului, the Orzaneaua and the Podul Giurgiului, and the Izvorul Mircea and the Buda, are of fluvio-glacial origin. In fact, these are nothing else but talus cones or alluvial fans, generally worn out and stratified (boulders and rounded gravel) by the flowing waters.

Acknowledgements

to all those who supported the accomplishment and publication of this article, within the project:"Evaluation and Monitoring of Avalanche Risk in the Context of Mountain Environment Organising and Planning. Case Study – Fagaras and Piatra Craiului Mountains", project manager Alexandru Nedelea, financed by CNSIS, category IDEI.

REFERENCES

[1] Nedelea A., Valea Argeșului în sectorul montan – studiu geomorfologic, Edit. Universitară, București, **2006,** pp. 229.
[2] De Martonne Emm., Rev.de geogr. annuelle, I, **1907**.
[3] Posea Gr., SCGGG, **1981**, XXVIII, 87.
[4] Niculescu Gh., Nedelcu E., Iancu S., Nouvelle contribution a l'etude de la morfologie glaciaire des Carpates roumaines. Recueil d'etudes geographiques, Bucureşti, **1960**.
[5] Nedelcu E., Probl. de geogr., **1959**, VI, 195.
[6] Voiculescu M., Studiul potenţialului geoecologic al Masivului Făgăraş şi protecţia mediului înconjurător,. Edit. Mirton, Timişoara, **2002**, pp. 375.
[7] Urdea P., Stud. şi cerc. de geogr, **1993**, XL, 65.
[8] Ghika-Budeşti Şt., Analele Institutului Geologic al României, **1941,** XX, 46.
[9] Nedelcu E., Munții Făgărașului. Creasta Râiosului - schiţă panoramică, Natura, 1968, 5, 52.
[10] Florea M., Munţii Făgăraşului - Studiu geomorfologic, Edit. Foton, Braşov, **1998**, pp114.
[11] Popescu N., Ielenicz M., AUB-Geogr., 1981, XXX, 89.
[12] Pişota I., Lacurile glaciare din Carpaţii Meridionali - Studiu hidrologic, Edit. Academiei R.S.R., Bucureşti, **1971, pp 164**.
[13]. Ielenicz M., Popescu N., Nedelea A., Morphodynamic system of the Făgăraş mountains alpine crests, Natural environment and civilization, București, **2005,** 3.