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PRELIMINARY OBSERVATIONS ON THE ROCK GLACIERS PHENOMENON IN THE ROMANIAN CARPATHIANS

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Observations préliminaires sur les phénomènes de glaciers rocheux dans les Carpates roumaines. On constate que dans les Carpates roumaines pendant le Würm, dans les principaux massifs (Rodna, Maramureș, Căliman, Retezat, Godeanu, Făgăraș, etc.) il y a eu des phénomènes de glaciers rocheux, premièrement déterminés par la déglaciation. Dans le climat actuel, on devine des glaciers rocheux en forme « embryonnaire », au-dessus de 2100—2150 m d'altitude absolue dans les Carpates Orientales, et 2 200—2 250 m dans les Carpates Méridionales.

The rock glaciers phenomenon in the Romanian Carpathians was first signaled out by Emm. de Martonne (1926 p. 862—863). He pointed out that "in the Carpathians, detrital deposits having a very doubtful moraine character are very likely to be stone runs"; in the same study, he found them to be "similar to the rock glaciers phenomenon in American connotation". In fact parallel to the rock glaciers notion, which was introduced by R. S. Capps (1910 quoted by A. Corte 1976), some other terms are also used such as : 'block streams', 'stone runs', 'boulder fields', 'lithoglaciers' etc. References to these phenomena (especially observations on the dynamics and morphology of the debris accumulations) are to be found in many works dealing with the glacial and periglacial morphogenesis in the highland area of the Carpathians.

The field literature has lately attempted to delimit more clearly some aspects particular to the 'rock glaciers phenomenon', as compared to some other phenomenon. In this connection, the problem of the rock glaciers presence in the Romanian Carpathians should be brought back to the forefront and reconsidered. This is necessary because, during the Pleistocene, the mountains were partially included in the glacial and totally in the morphogenetic periglacial storey. Therefore, rock glaciers are likely to have been a reality in this mountain area, the more so as such Würm age phenomena have been clearly identified (P.-Y. Péchoux, 1970) in southerner massifs, e.g. the Parnass massif (38°40′ North. latitude, 1950 m altitude). Moreover, the analysis of the rock glaciers viewed as a leading morphoclimatic indicator (for the snow line, permafrost presence, assessment of average annual rainfalls etc.) could bring new elements in estimating the morphogenetic conditions in the Pleistocene.

As regards the definition, typology and significance of the rock glaciers phenomenon, no consensus has been reached ; this has determined us to start by making some general remarks, before going into details.

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Rock glaciers are unsorted debris accumulations up to 50 m thick (sometimes included in a mass of deposits of smaller granulometry). These accumulations are talus, lobe, spatula, or tongue shaped, rock glaciers of valley etc. and are most frequently situated in the transition area between the glacial and the periglacial storey. They could often be 300 to 1600 m long (R. J. E. Brown, 1973), although cases of over 9—12 km were also recorded (L. Lliboutry, 1950, A. Corte, 1976); their general declivity averages 10° to 20° (L. E. Hamelin, Fr. Cook, 1967) with 10 to 100 m steep slopes in the end (R. J. Brown 1973). Fragmentation is due to countless depressions of irregular shape (some of them, several maters deep and tenths of meters long), transversal arches, longitudinal bands etc. Some authors consider that deglaciation is the ideal phenomenon leading to the emergence of rock glaciers, but most of them claim that rock glaciers "shouldn't necessarily be looked upon as an effect of deglaciation". It is important to remember that the rock glaciers genesis requires at least two elements : strong weathering rate and the presence of ice in the debris of deposits. In connection with the latter aspect either 'ice cores' could be involved, left from withdrawal of glaciers (this is the typical case of black glaciers formation) (Claudine Orengo, 1973) or ice is resulting from the accumulation of snow lingering back in depressions all the year round, since late winter through spring and summer. Many rock glaciers are also formed in the presence of interstitial ice which is usually due to the freezing of waters draining through the debris mass (especially talus type) in spring time; or, they may also emerge, according to R.J.E. Brown (1973), when, in spite of a lower than 0°C average air temperature, the daily oscillations enable, however, on the one hand, a slow snow melting and, on the other hand, a drop-by-drop trickle down of water freezing to ice.

The rock glaciers dynamics varies within a 5—10 cm/year range (E.S. White, 1971); it may as well reach 150 cm/year and even more (D. Barach & G. Hell, 1975), depending on the ice distribution in the deposits mass, its balance and the configuration of the substratum on which the draining movement takes place. The presence of rock glaciers points to a continental periglacial droughty climate, with wide variations of temperature between day and night, annual average temperatures lower than 0° and —1°C and prevailing snowfalls. The assessment of the annual rainfalls quantity is controversial : according to some opinions, they reach at most 1000—1200 mm/year, although others such as Victoria Guiter (1973) claim the figure is even lower (500—600 mm/year). Most research workers have noticed, however, wide variations according to specific regional conditions. As regards the significance of rock glaciers we should also mention that most studies situate them at the lower snow line limit. D. Barsch (1971) considers that in the Alps they could be found 400 m lower than the snow line.

Starting from the characteristics defining rock glaciers, we made observations in some massifs of the Romanian Carpathians (Maramureș, Rodna, Căliman, Hășmaș, Retezat, etc.) and drew the conclusion that both fossil and active rock glaciers were present in these mountains.

1. *Fossil rock glaciers.* In the Maramureș mountains, in the basin of the Iutna river, on the northern slope of the saddle between the Mihailec

and Farcău peaks, at 1450 m altitude, we identified a rock glacier with tranversal arches, and depressions, a microrelief which could be due to the melting of ice cores. On the western side of the Mihailec peak, on a plateau with a glacis general declivity, there are many depressions and debris accumulations ; the thermokarst played a decisive role in the emergence of this relief, in the process of a mass glide. On the Pietrosu peak, there is a microrelief ensemble which could be equally considered a rock glacier, though I. Sîrcu (1971) claims it is a relief of "circus and moraines' ; the same situation was signaled out on the western slope of the Rugașu mountain and M. Bleahu (quoted by I. Sîrcu, 1971) claimed it is a morphology created by gliding under conditions of permafrost. There are many other cases of rock-glaciers-like phenomena in these mountains and it is significant that they cover a prevalence area below 1500 m altitude.

In the Rodna mountains the presence of rock glaciers, rock glaciers of valley included, is significant as the mountains are massive and were covered by the glacial storey to a larger extent ; some of the rock glaciers of valley (Cobășelul Valley, Negoescu Valley, Puzdrele, etc.) could be ranked among the so-called black glaciers. The debris accumulations in some circuses point, if taking into account their morphology, to a rock glaciers phase due to deglaciation. Such a phase has not been differentiated so far and consequently, typical glaciers were mistaken for other phenomena. For instance, such a case was found on the southern slope of the Cișa summit, which L. Sawicki (quoted by I. Sîrcu, 1962) claimed it is an effect of circus glaciers and I. Sîrcu a glide, that is a glide with lateral arches.

In the Căliman mountains, the debris accumulations below the Pietrosul peak and the Rătitiș mountain could also be ranked as rock glaciers.

In the Southern Carpathians, rock glaciers phenomena are more representative as regards the extension area and have a more varied typology ; this is due to the fact that, during the Quaternary ice age, this was the most extended area in Romania covered by ice since altitudes were over 2500 m (the highest peak, Moldoveanu, is 2543 m).

The transversal rock glaciers are, however, prevalent. We have made more comprehensive observations in the Retezat mountains, where such phenomena which are mainly due to deglaciation were found along most of the glacial valleys. From this point of view the glacial-periglacial relief complex in the Bucura area is representative.

For instance, just below the Judele peak, as well as along the Pietrele, Galeșul, Valea Rea Valleys, depressions formed by the melting of ice cores in the debris mass go deep down to 3–5 m and are 20 to 30 m wide. In our opinion, microdepressions on the fixed or mobile debris at the foot of some slopes in the Godeanu mountains, or the accumulation in the western side of the Galbena circus (in the same massif), with high arches of rocks, partly fixed and partly loose boulders (which Gh. Niculescu, 1965 views as complex nivation protalus), could also be looked upon as rock glaciers phenomena. Gh. Niculescu and E. Nedelcu (1961) mentioned in the Făgăraș and Iezer mountains 'nivation protalus in successive arches' — a typical rock glaciers morphology. We have not seen these cases, but the detailed presentation made by the quoted authors endorse the above-mentioned statement.

In conclusion, we claim that fossil rock glaciers are indeed present in the Romanian Carpathians. We have only signaled them out; a systematic survey will certainly contribute to a more comprehensive image of the morphoclimatic conditions in this area of the Carpathians during the Pleistocene.

2. *Active rock glaciers.* In the present climatic conditions in the Carpathians, at over 2000 m absolute altitude, the average annual temperatures go down well below 0°C. In other words, there are thermic conditions for the rock glaciers formation, the more so as at higher altitudes, the frost period may cover 8 months/year (Atlasul R. S. România 1974). Field research on the snow persistence from one year to the other in the Rodna and Retezat mountains, led us to the conclusion that at higher than 2200–2250 m altitudes (in the Retezat mountains) and 2100–2150 m (in the Rodna mountains), on sheltered slopes and in some depressions at the base of the circuses snow lasts from one year to the other, sometimes for 3 to 4 years. Of course, surfaces covered with snow lasting from one year to the other are relatively small and could not be considered favourable conditions for ice cores formation. However, under these thermic conditions, active rock glaciers should be present. The findings in the two mentioned mountains pointed to the existence of elementary talus or lobe-shaped rock glaciers, at over 2200 m altitude in the Retezat mountains and 2100 m in the Rodna mountains (taking into account that, according to many authors, a condition required for the identification of the active phenomenon is the mobile debris, in the frontal part of the mass movement of deposits. In August 1977, in the Retezat mountains, we found interstitial ice (50 to 70 cm thick ice cores) in the active debris mass below the Judele peak (to the Bucura Circus). The length of these rock glaciers very seldom exceeds 100–150 m and even less so in the Rodna mountains (on the northern slope of the Repede peak, in the Iezeru circus etc.). In connection with this phenomenon, we would like to mention, however, that the movement is mainly taking place in the older debris deposits (possible Late Pleistocene), which has not yet been fixed and that the present disaggregation rate would not 'replace' or cover the older deposits. In any case, the phenomenon deserves a more careful analysis in the researches on the present periglacial morphogenesis in Romania.

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