

## Rock glaciers in the Bulgarian high mountains

Alexander Gikov\* and Petar Dimitrov

Space Research and Technology Institute - Bulgarian Academy of Sciences, Bulgaria, [gikov@abv.bg](mailto:gikov@abv.bg)

Despite the fact that the term rock glacier was first used in the Bulgarian scientific literature in the middle of the 20-th century these periglacial landforms of the high Bulgarian mountains have long remained unexplored. It was only recently that the results from new studies were published and relict rock glaciers were ascertained and mapped in many parts of the Rila and Pirin mountains.

Rock glaciers are positive landforms representing a body of unsorted, angular debris in the form of a tongue at the valley floor or lobe at the slope base. They have characteristic morphology expressed in the steep slopes and the system of ridges and furrows on their upper surface. Because of their characteristic appearance rock glaciers can be successfully identified and mapped using remotely-sensed imagery. For identification and mapping of the relict rock glaciers in Rila and Pirin Mountains aerial and satellite imagery with very high spatial resolution have been used.

**Rock glaciers in Rila Mountain.** Back in 1959, M. Glovnya was the first Bulgarian geomorphologist to use the term rock glacier to refer to a small landform north of the Musala peak. However, in his later studies of the periglacial landforms in Rila Mountain this term was not used. Some recent publications have mentioned the existence of rock glaciers without providing details.

In this study 27 rock glaciers are identified and mapped using remote sensing methods and then verified on the field. Based on the observations of their morphology and significant vegetation cover it can be argued with a high confidence that these rock glaciers are exclusively relict forms.

The overall area of the rock glaciers in Rila Mountain is estimated to 153.5 ha. The largest one is situated in the northwestern part of the mountain in the foot of the Mechit peak (2568 m a.s.l). Its length is 865 m and the area is 20.6 ha. The root zone is at 2350 m a.s.l and the front is at 2140 m a.s.l. The highest is the rock glacier situated north of the Musala peak (2925 m a.s.l). Its altitude is between 2600 and 2690 m. In a regional perspective, rock glaciers are distributed rather evenly between the three highest parts of the Rila Mountain. Only in the lowest part – Southwestern Rila there is no rock glaciers.

**Rock glaciers in Pirin Mountain.** The existence of rock glaciers in Pirin Mountain have only recently been documented even though its altitude and environment are very similar to that of the Rila Mountain. Using the same remote sensing and field verification methods a total of 55 rock glaciers were identified and mapped. Probably all of them are relict too. The total area of the rock glaciers in Pirin Mountain is almost three times greater than that of the rock glaciers in Rila Mountain. The largest rock glacier in the mountain is situated on the western slope, at the foot of Kuklite peak (2686 m a.s.l). The altitude of the rock glacier is between 2180 m and 2350 m a.s.l. Its length is 1100 m and the area is 30.5 ha. In Pirin Mountain there are four rock glaciers with area over 20 ha all of which are greater than the largest Rila Mountain rock glacier. Unlike Rila Mountain, significant part of Northern Pirin Mountain is build of carbonate rocks. There were no rock glaciers identified in this part of the mountain.

It appears that the specific drainage conditions in these karst areas do not favor the formation of rock glaciers.

The debate on the origin of the rock glaciers in Bulgaria is still opened. The fact that they are present only in the two highest Bulgarian mountains where there are undoubted evidence for alpine glaciation during the Pleistocene, but are lacking in Stara Planina, Osogovo and other high mountains, suggests that they might be formed mainly by transformation from ice glaciers to rock glaciers. Most likely, this happened at the beginning of the Holocene. Later on, with the rise of the global temperatures, the interstitial ice melted and they became relict rock glaciers. It is possible also that a few rock glaciers formed in periglacial conditions without interaction with alpine glaciers. It could be assumed that some of the highest located rock glaciers had an active phase during the Little Ice Age.