

Inventory and Spatial distribution of rock glaciers in the Eastern Pyrenees: paleoenvironmental implications

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In this communication we present a detailed analysis of the spatial distribution and morphometric characteristics of all the rock glaciers identified in the massifs located in the easternmost fringe of the Eastern Pyrenees. From west to east, this area encompasses the massifs of Puigmal (2910 m)-Bastiments (2881 m)-Costabona (2465 m) and Canigó (2784 m). The presence of rock glaciers in these mountains shows evidence of the cold-climate geomorphological processes that occurred during the Late Pleistocene in the Pyrenees. Moreover, they constitute a paleoclimate indicator of the conditions that occurred during their development.

Up to 122 rock glaciers have been identified, either formed by individualized or by complex landforms formed by coalescence units. For each of these units several variables have been determined: a) location: topographic and geomorphological setting, valley and flow aspect, maximum and minimum elevation, slope, maximum and mean slope; b) lithology and morphology: underlying/prevaling lithology, general morphology, surface morphological features, grain size characterization, vegetation cover, degree of preservation, maximum elevation of the surrounding area; and c) morphometry: maximum length of the landform in the flow direction, width, perimeter and total surface.

The Puigmal-Bastiments-Costabona massifs, most extensive and higher, concentrate 89% of the landforms, while the Canigó massif encompasses the remaining 11%. Most of them are located on the north slopes (69%), with a significant percentage south exposed (31%). In total, they extend over an area of 985 Ha. The distribution of rock glaciers in the study area presents significant irregularities, with a remarkable asymmetry between slopes in some sections. Consequently, we have also analyzed the dual presence/absence of rock glaciers based on the identification and morphometry of all headwaters that due to their altitude and/or morphotopography could be susceptible to house them. With this purpose, we have identified a total of 149 headwaters, located above 2200 m and with concave morphology (50.3% N slope, 49.7% S slope). In 74% of these units, glacier cirques developed, though only 64% of them housed rock glaciers. No rock glaciers are found outside the formerly glaciated area (cirque, slope or valley bottom). Therefore, 26% of the high headwaters that were not glaciated and 34% of those that were glaciated but did not develop rock glaciers.

The analysis of the morphotopographic characteristics of the high headwaters that were not glaciated during the Last Glaciation shows that the unfavourable aspect, exposure to prevailing winds, insufficient catchment area and steep catchment slopes explained the absence of glacier ice accumulation. However, it is not so obvious to interpret the absence of rock glaciers in a significant number of glacial cirques, which will require further analysis.