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The deglaciaton of the Pyreenes: from the Oldest Dryas to the Little Ice Age

David Palacios (1), Nuria de Andrés (1), Juan I. López-Moreno (2), and José M. García-Ruiz (2)

(1) Universidad Complutense, Physical Geography, Madrid, Spain (davidp@ghis.ucm.es), (2) Instituto Pirenaico de Ecología, CSIC, Campus de Aula Dei, P.O. Box 13.034, 50.080-Zaragoza, Spain.

The main purpose of the paper is to study the deglaciation process, including the retreat of the glaciers and the occurrence of short advances with the deposition of new, relatively recent tills in two head valleys of the central-southern Pyrenees: The Upper Gállego Valley, with the main peak Balaitus (42°46'0" N, 0° 15'0"W, 3151 m), and the Marbore Cirque, at the head of the Cinca Valley, on the north face of the Monte Perdido Peak (42º400" N; 0.5º0"W; 3355 m). The deglaciation process was studied through geomorphological mapping and 36Cl cosmogenic exposure ages obtained from morainic and rock glacier boulders and polished bedrocks. Even though the exact position of the front glacier during the global Last Glacial Maximum is not known, there is evidence that the different ice tongues retreated until headwater positions, causing the subdivision of the main glaciers into various individual glaciers. Two clear climate reversals within the general trend to deglaciation have been detected: First of all, the Oldest Dryas, coinciding with the Heinrich Event 1 (ca 17–15 ka) and, secondly, the Younger Dryas (ca 13–11.7 ka). Between both stadials, the Bølling/Allerød Interstadial (ca 15-13 ka) represented an intense glacial retreat up to the cirque headwalls. During the Bølling/Allerød Interstadial the retreat was very rapid, although the occurrence of a short readvance of small glaciers during the Older Dryas must not be ruled out. The Younger Dryas is represented by a new glacial push with the deposition of distinct types of tills. During these late glacier advances, small glaciers and rock glaciers developed close to the cirque headwalls, and coexisted under the same climatic conditions. After the Younger Dryas, new glacial advances has not been detected until the Little Ice Age, except in the Marbore Cirque, where glacial expansion occurred during the Mid and Late Holocene (5.1 $\pm$ 0.1 ka), represented by a large push moraine. A melting phase occurred at approximately 3.4 $\pm$ 0.2 and 2.5 $\pm$ 0.1 ka (Bronze/Iron Ages) after one of the most important glacial advances of the Neoglacial period. A melting period occurred during the Medieval Climate Anomaly following a glacial expansion during the Dark Age Cold Period (1.4-1.2 ka). The Little Ice Age represented a clear stage of glacial expansion within the Marboré Cirque. Two different pulses of glaciation were detected, separated by a short retraction. The first pulse occurred most likely during the late 17th century or early 18th century (Maunder Minimum), whereas the second occurred between 1790 and 1830 AD (Dalton Minimum).