



Geochronological reconstruction of the glacial evolution in the Ésera valley (Central Pyrenees) during the last deglaciation

Ixeia Vidaller¹, Toshiyuki Fujioka², Juan Ignacio López-Moreno¹, Ana Moreno¹, ASTER Team^{3,*}

¹ Instituto Pirenaico de Ecología, Consejo Superior de Investigaciones Científicas (IPE-CSIC), Zaragoza, Spain

5 ² Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain

³ CNRS, Aix Marseille Univ, IRD, INRAE, CEREGE, Aix-en-Provence, France

* Aster Team: A full list of authors appears at the end of the paper.

Correspondence to: Ixeia Vidaller (ixeia@ipe.csic.es)

Abstract. The last deglaciation period in the Pyrenees was distinguished by intricate glacier dynamics, encompassing a multitude of advances and rapid glacier retreats that did not always align with the fluctuations observed in other European glaciers. The Ésera valley, located in the Central Pyrenees (northern Spain), provides a distinctive opportunity to reconstruct past climate in high-mountain regions during the last deglaciation period. Previous studies of glacial evolution in this area have employed a variety of methods, including the analysis of glacial lake sediments and detailed geomorphological studies of glacial landforms. This paper presents measurements of cosmogenic ¹⁰Be exposure ages from glacial deposits and a polished bedrock surface in the Ésera valley, together with calculations of the equilibrium line altitude (ELA), with the objective of reconstructing the evolution of the Ésera glacier and the associated environmental implications during the last deglaciation. Following the Pyrenean Last Glacial Maximum, at approximately 75 ka in the Ésera valley, the Ésera glacier commenced a period of retreat during the Marine Isotopic Stage (MIS) 3, reaching a point of stabilisation at approximately 47 ka at the location of the Pllan d'Están proglacial lake. Subsequently, a new glacial advance resulted forming the Llanos del Hospital moraine (~16 ka), a glacial deposit located at a lower altitude in the valley than Pllan d'Están lake. During that time interval, we suggest that sediment deposition at Pllan d'Están took place in a subglacial environment. Following the conclusion of the Oldest Dryas period (~16 ka) and continuing into the Early Holocene, the Ésera glacier underwent a rapid retreat. The Little Ice Age (LIA) represented the last cold period documented in the Ésera valley, after which the glacier has exhibited a persistent retreatment. The ELA analyses indicate that the temperature in the Ésera valley increased by 3.6 ± 0.45 °C over the past 16 ka, which resulted in the retreat of the glacier front from 1750 metres above sea level (m a.s.l.) to 3000 m a.s.l.

Keywords: cosmogenic exposure dating, Pyrenees, last deglaciation, glaciers, glacial paleogeography, paleoELAs.

1 Introduction

Glaciers are highly effective indicators of climate variability due to their sensitivity to climate change, particularly in relation to temperature and precipitation. Consequently, their thickness and surface variations are regarded as one of the most informative proxies for global warming in mountainous regions (e.g. Beniston et al., 2018; Braithwaite and Hughes, 2020). A