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Glacial evolution during MIS 4-3 in Picos de Europa (Spain) based on cave sedimentation and paleontological remains

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Glacial studies in mountain areas are hampered by the erosion of the sedimentary record, among other factors. However, in limestone areas, the traces of glacial advances and retreats can be recorded in karst cave deposits. This is the case of Picos de Europa mountains (N of Spain), which was covered by Pleistocene glaciers. In these mountains, previous studies established a local maximum at around 45 ka covering an extension of 180-190 km2, a subsequent general retreat after 37-39 ka, an advance associated with the Last Glacial Maximum, and the later disappearance after retreat. However, other advances and retreats during the Last Glacial Cycle remain practically unknown. Thus, we study the geomorphology of a karst cave named Hayéu del Osu (3.5 km length, 226 m depth) and its preserved palaeontological records to provide new data about the glacial evolution of Picos de Europa. The study cave has entrances located at 1250-1350 m altitude, 1 km south of the Covadonga Lakes, which represent a reference location for glacier research in the northern Iberian Peninsula. The geomorphological study of this cave reveals the presence of allochthon alluvial sediment that comes from the erosion of the upper part of the glacial valleys located to the S. The sediments were transported toward the N by fluvioglacial processes, finally entering into the cave. Five OSL ages allowed us to date two alluvial sedimentary sequences: 1) a first sequence deposited at 84-65 ka, and 2) a second sequence deposited 36 ka ago. Both sequences include fragments of dental enamel of Arvicolinae, an unusual evidence during MIS 4 in the NW Spain, especially in high areas. Moreover, bones of at least three individuals of chamois (Rupicapra pyrenaica) found in the cave were dated in 34-32 ka cal by AMS radiocarbon dating. All the fauna found in the study cave was not adapted to cold environments, as those covered by glaciers. These results provide data about glacial evolution in the area: 1) the glacier fronts were located at more than 1350 m altitude during 84-65 ka (mainly MIS 4); 2) according to previous research, a glacier advance took place at 45 ka with glacial fronts reaching up to 900 m asl; and 3) the retreat of the glaciers more than 3 km to the S from 45 to 32 ka, coevally with the second half of the MIS 3.