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Late-Cenozoic evolution of the northern Pyrenean foreland inferred from the incision of the Lannemezan megafan

Margaux MOUCHENE (1), Peter van der Beek (1,2), Frédéric Mouthereau (3), Julien Carcaillet (1,2)

(1) Univ. Grenoble Alpes, ISTerre, F-38041 Grenoble, France, (2) CNRS, ISTerre, F-38041 Grenoble, France, (3) GET, Univ. Paul Sabatier, F-31400 Toulouse, France

Deciphering the incision history of elevated piedmont paleosurfaces can provide critical information to distinguish between climatic and tectonic forcing on the current landscape. A measure of the temporal and spatial incision patterns at Quaternary timescales can be obtained through the analysis of geomorphic features and their dating using cosmogenic nuclides. In the Pyrenees, Quaternary glaciers did not migrate far into the foreland, thus leaving elevated surfaces relatively well preserved. In particular, the Lannemezan megafan is the most striking morpho-sedimentary feature of the northern Pyrenean foreland. It was built from Early Miocene to Pliocene times, while active deformation of the central Pyrenees, in particular its northern retro-wedge, had already ceased. The Neste River, which most likely used to feed the megafan, now bends 90° eastwards near the apex of the fan, indicating it was captured by the larger Garonne River in Quaternary times. A river network that spreads out radially from the apex has been incising the fan itself since its abandonment. A well-developed alluvial terrace staircase was cut in the riverbanks by successive episodes of incision. We combine a quantitative morphometric analysis of the river network with field observations and cosmogenic dating to assess the Quaternary evolution of the Lannemezan fan and surrounding northern central Pyrenean foreland. Our geomorphic analysis of the incising rivers (long profiles, steepness indices, knickpoints) shows no evidence of an active tectonic feature situated directly beneath the fan that could have imprinted the incision of the fan. We use a proxy for steady-state channel elevation (χ) to analyze drainage network reorganization through divide migration and river capture. We show that the terrace slope increases with time and the modern rivers exhibit markedly concave long profiles, which could indicate late tilting of the fan, possibly under extensional tectonic constraints. New cosmogenic nuclide analyses (^{10}Be, ^{26}Al) are used to date the abandonment of the fan surface and the terrace staircase chronology to provide constraints on incision rates and mechanisms.