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New insights into the origin of low relief surfaces at the Pyrenees and their relationship with an internally drained plateau

Maria Ortuño (1) and Marc Viaplana-Muzas (2)

(1) RISKNAT Group, GEOMODELS Research Institute, Departament de Dinàmica de la Terra i de l'Oceà, Facultat de Ciències de la Terra, Universitat de Barcelona, 08028 Barcelona, Spain (maria.ortuno@ub.edu), (2) 2Group of Dynamics of the Lithosphere (GDL), Institute of Earth Sciences Jaume Almera (ICTJA-CSIC), Lluís Solé i Sabarís s/n, 08028 Barcelona, Spain

Paleogeographic reconstructions of mountains based on surviving landforms are challenging; erosion tends to erase the landscapes prevailing in the upper parts, and outwash sediments, to cover those formed the mountain flanks. Moreover, erosion leads to unload the orogen, often producing enhanced isostatic uplift, which retro-feeds the erosion. In this work, we analyze clue geomorphic markers generated and preserved at the top the Pyrenean mountain range; the low relief surfaces (LRS). The studied LRS are identified as regions located over ∼1200 m, where the relief is lower than 350 m. These landforms are interpreted as part of a relatively smooth landscape existing before the Plio-Quaternary incision, and were mapped through a semi-automatic procedure based on 60 m resolution DEM, with individual revision of their location to discard more recent origins. The mapped remnants represent 20 % of the total area of the range, and served to digitally reconstruct a synthetic surface broadly representing the pre-Quaternary paleo-topography of the Pyrenees. The analysis of the spatial distribution of the LRS with respect to the tectonic structure, Present-day altitudes, lithologies and possible paleo-base levels allowed us for the identification of three types of surfaces: 1) inner LRS, developed on basement and cover rocks and bounded by paleo-divides (ridge-lines) encircling an internal plateau; 2) Southern outer LRS, developed on Paleogene and Miocene sediments mantling the southern flanks, and; 3) Northern and Eastern outer LRS, formed on top of basement rocks. Such a configuration leaded us to propose the existence of an internally drained plateau, perhaps connected to the flanks only at certain outwash points and dominating the post-orogenic landscape prior to the onset of the Present-day network. Accordingly, besides two previous models proposed to explain these LRS (i.e. the "raised peneplain model" for the Eastern LRS, and the "raised base-level model" for the Southern LRS), we propose that the LRS preserved at the highest parts of the Pyrenees are likely to be the remnants of an inner plateau, surrounded in the past by ridge-lines tectonically controlled. This analysis leads to understand the low relief landscape as the result of different mechanisms (polygenic nature), probably asynchronic and dependent of local base levels. The conditions for the preservation of the LRS are discussed in terms of the efficiency of sediment removal from the flanks, tectonic activity and recent uplift of the Pyrenees