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Gravity modeling reveals that the "Miocene Pyrenean peneplain" developed at high elevation

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Geodynamics that shaped the present morphology of the western Mediterranean are mostly linked to the African-Eurasia collision and the extension related to the Mediterranean opening. The Pyrenean chain formed by the collision between the Iberian microplate and the Eurasian plate from the Eocene to the late Oligocene. This resulted in lithosphere thickening especially below the Central Pyrenees that becomes thinner eastwards. Whether the later thinning of the lithosphere in the easternmost Pyrenees involves the removal of the lithospheric mantle or not is debated. This issue joins the problematics about the origin of the high-elevation of the "Miocene Pyrenean peneplain" remnants. Indeed the most striking feature of the Pyrenean morphology is the occurrence of high-elevation, low relief erosional surfaces that are interpreted as the remnants of a Miocene single planation surface, dissected and reworked by Quaternary fluvial and glacial erosion. Two end-member interpretations have proposed to explain the high elevation of this original surface. The first considers that the Miocene Pyrenean peneplain develops near sea-level and was later uplifted, the second claims that the planation surface developed at high elevation in response to the inhibition of erosion consecutively to the progressive rise of the base-level of the Pyrenean drainage network. The first interpretation implies the return to normal crustal thickness by erosion and later uplift by removal of the lithospheric mantle. The second interpretation considers that the mean elevation of the original planation surface matches the thickness of the lithosphere below the chain, taking into account some hundred meters of isostatic rebound due to Quaternary erosion.
To test these interpretations, we first restore the Miocene original planation surface by mapping and interpolating the high-elevation, low relief surfaces across the Pyrenees. We then performed 1D and 2D gravity models that we compare with recent seismic data compilations. We show that (1) Miocene high-elevation, low relief surfaces do exist in the Central Pyrenees, contrary to previous assertion, where the crust has been significantly thickened; (2) the gravity models and seismic data are in agreement, indicating that there is no overcompensation of the Pyrenean chain as previously claimed; (3) the dissected Pyrenean planation surface is isostatically compensated by crustal thickening, indicating that there is no or a little residual topography and (4) there is no removal of the lithospheric mantle in the eastern Pyrenees, so the high elevation of the low-relief surfaces in this area are not linked to any asthenospheric upwelling as recently proposed. We conclude that there was no major uplift in the Pyrenees since the Late Miocene and that therefore the Miocene Pyrenean peneplain formed at high elevation.