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Oxygen isotope of mollusc shells record a middle Eocene elevation change in the Pyrenees

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Constraining paleoaltimetry of collisional orogens is critical to understand the geodynamics of topographic evolution and climate/tectonics retroactions. Here, we use oxygen stable-isotope record on oyster shells preserved in marine foreland deposits to determine the middle Eocene elevation of the Pyrenees. We propose a new approach based on the comparison between the oxygen stable isotope composition of marine oyster shells of the south-pyrenean foreland basin and the intracratonic Paris basin, used as a low-elevation reference. The δ18O of oyster shells shows a shift of $\sim$1.5‰ between 49 and 41 Ma that is interpreted to reflect the control by negative δ18O rivers from the Pyrenees.

To test this possibility, we have developed a morphologic-hydrological model reproducing the 3D relief of mountain belts coupled with mass-balanced modelling of δ18O. We deduce a maximum elevation of $\sim$3000 m for the Pyrenees during the middle Eocene and an area weighted mean elevation of 725 m. This result suggests that the Pyrenees were close to their modern topography in the middle Eocene. It finally questions the possible mechanisms allowing preservation of the Pyrenean topography. Among other factors, the development of the internally-drained Ebro basin at 36 Ma, and the deposition of piedmont sediments associated with the rise of the local base level, have certainly played a role by reducing the erosional capacity of rivers. The subsequent post-orogenic re-excavation of river valley fill by the capture of the Ebro basin at 10 Ma led to recover the original Eocene topography.