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Constraints on Mid-Eocene paleo-altitudes of the Pyrenees from stable-isotope analysis on oyster shells

Damien Huyghe (1,2), Frédéric Mouthereau (1,2), Laurent Emmanuel (1,2)
(1) UPMC, Univ. Paris 06, ISTeP, UMR 7193, F-75005, Paris, France, (2) CNRS, ISTeP, UMR 7193, F-75005, Paris, France

Fission-track ages on apatite, zircon and 40Ar/39Ar ages on K-feldspar from the Axial Zone of the Pyrenees indicate that collision-related exhumation ca. 50 Ma. Exhumation was associated with frontal accretion and wedge widening during the Ypresian and until the Bartonian. At the Eocene-Oligocene boundary exhumation accelerated at the Eocene-Oligocene transition. However, it is not clear if exhumation was associated with topographic uplift or decay. But the coeval deposition of conglomerates, backstepping onto the Axial Zone, argues for a reduction in elevation.
In order to provide first constraints on the elevation of the Pyrenees during the initial phase, we have compared the oxygen stable isotope composition of oysters shells collected in from the Ypresian to the Bartonian in the southern foreland with those collected for the same period in the Paris intracratonic basin assumed to be tectonically stable at this time.
Our results show that oyster shells from the Pyrenees have mean ∂18O values more negatives than those from the Paris basin. Taking into account the influence of the salinity, the mean statistical difference between the two populations of oysters is 1.23‰ during the Middle Eocene, between 47.9 and 41 Ma. During this period, many reconstructions show the latitudinal gradient of temperature was very low and can not explain the difference observed. The remaining factor that could have influenced the 18O ratio is the orographically-controlled precipitations captured by the southern river drainage system in the South Pyrenean Foreland Basin. To test this hypothesis, we have performed a simple model that combines a realistic drainage system with the main trunk stream that carry water downstream but that receive waters from surrounding ridges and tributaries. Using calibrated ∂18O lapse rates in precipitation we derive the 18O at basin outlet. This study finally emphasize that the oxygen stable isotopic record on oyster shells can be used as a proxy for determining the past elevation of orogenic wedge provided that the erosion laws, climate are independently known and that a reference basin with the same climatic characteristics can be studied.