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Geometries and source-to-sink analysis of a retro-foreland basin during its late to post-orogenic evolution: the case example of the Pyrenees / Aquitaine Basin / Bay of Biscay from 38 to 0 Ma

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The purpose of this study is to understand the "source-to-sink" evolution of the Pyrenees system and its retro-foreland basin, the Aquitaine basin and its deep equivalent, the Bay of Biscay during the Cenozoic. This work required (1) a biostratigraphic re-evaluation, (2) an analysis in terms of seismic stratigraphy and quantification of preserved sediment volumes, (3) a quantification of eroded volumes from the Massif Central, (4) a quantification of the eroded volumes from the Pyrenees, (5) a synthesis of all these data.

In the Aquitaine basin, the transition from the orogenic to the post-orogenic phase occurs between 27.1 and 25.2 Ma. The orogenic period is divided into two phases, (1) up to 43.5 Ma (Lutetian), is characterized by a strong subsidence at the front of the North-Pyrenean-Thrust, (2) from 43.5 to 27.1 Ma, is characterized by the subsidence migration toward the basin, in sub-basins controlled by the thrusts and the inverted structures activity. The post-orogenic is identified by the succession of three erosional surfaces that fossilize the entire compressive structures period. This period is divided into two phases, (1) from 25.2 to 16 Ma approximately, corresponds to the establishment of the isostatic rebound in the Aquitaine basin, (2) between 16 and 10.6 Ma, corresponds to an uplift of the whole system. This latter phase corresponds to a West European event undoubtedly linked to a mantle activity.

The total quantity of rocks preserved in the Aquitaine basin and the Bay of Biscay is 92 200 km³. The distribution of sediments preserved over time evolves in favour of the Aquitaine basin between 66.0 and 33.9 Ma and in favour of the Bay of Biscay between 5.3 and 0 Ma. This balance is due to the different stages of evolution of the subsidence / uplift in the Aquitaine basin. The sedimentation rates show two periods of increase in sedimentary fluxes, the first at the Eocene-Oligocene limit in the two basins, which we relate to both the period of Pyrenean paroxysmal exhumation and to contemporary global cooling. The second, at 5.3 Ma exclusively in the Bay of Biscay, seems to correspond to the global increase of fluxes, whose climatic origin is favoured by the authors.

From the inversion of the extensive thermochronological dataset in the Pyrenees and the geomorphological analysis of the planation surfaces of the French Massif Central, we obtained the total amount of eroded rock which is 34 335 km³. The difference observed between the sedimented volumes and the eroded volumes can be explained by the contribution of sediments resulting from the currents from the Pliocene, the not taking into account the volumes coming from the Cantabrian massifs, an underestimation of the eroded volumes and of the terrigenous carbonate fraction in the two basins.