

Gravity anomalies, spatial variation of flexural rigidity, and role of inherited crustal structure in the Aquitaine Basin

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The Aquitaine foreland basin developed from Campanian to Miocene by flexure of the upper (European) plate during the Pyrenean orogeny. The foreland basin forms a syn-orogenic sedimentary wedge up to 6 km thick in the south, thinning rapidly north and has a maximum width of 200 km in the west. The flexural basin was superimposed on a lithosphere previously affected by Apto-Albian hyper-extension. What are the effects of an inherited extremely weak and narrow rifted zone on the behavior of a superimposed flexural foreland basin? Coupled with surface and subsurface data, Bouguer gravity anomalies were used to determine the crustal structure of the northern Pyrenean retrowedge and the flexure of the European plate.

In the centre, the basin shows a regional Bouguer anomaly pattern typical of foreland basins with the maximum of syn-orogenic deposits corresponding to a low and the forebulge to a high. However, south of the North Pyrenean Frontal Thrust (NPFT) this regional field is overprinted by strong positive Bouguer anomalies, which correspond to high density bodies (mantle or lower crust) transported along the NPFT. Stratigraphy shows that the central basin evolved as a series of narrow, laterally variable depocentres that migrated north. Shortening is accommodated mainly by thick skinned deformation and local reactivation of salt structures. In the east, the Toulouse Fault separates the central and eastern foreland. The eastern foreland shows a broader zone of negative Bouguer values. This foreland is salt-free and stratigraphy records higher subsidence. The easternmost basin is completely overprinted by the opening of the Gulf of Lion. In the west, the foreland does not show a typical regional gravity anomaly pattern due to overprinting by the opening of the Bay of Biscay. Instead, a major gravity high is centered on the northern Landes High, with a second high centered on the Labourd massif south of the NPFT. Neither the Parentis rift basin nor the salt-rich foreland basin have a distinct Bouguer signature. Overall the gravity field is high.

Modelling of the Bouguer anomaly field is used to constrain lithosphere rheology (T_e , elastic thickness) of the European plate. The European foreland shows lateral variations in flexural behavior: T_e values decrease toward the west, due to thinning of the European lithosphere during Apto-Albian rifting. The complex geometry and infill history of the Aquitaine foreland basin is therefore due to (a) inversion and loading of a variably thinned rift system and (b) local emplacement of significant high density slices into the upper crust during the Pyrenean orogeny.