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Lithosphere buckling: a model for mountain building and basin development in Iberia.

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The N-S convergence between Africa and Iberia during the Pyrenean stage of the Alpine Orogeny is responsible for fault reactivation and surface uplift. The Cainozoic deformation accommodated within the Iberian microplate may be explained by lithospheric buckling. It resulted in the development of fault corridors that transferred the deformation from the Pyrenees-Cantabrian Mountains to the plate interior leading to inversion of Mesozoic rift basins. The spatial distribution of the mountain ranges represented by upper crustal pop-ups are the main agents advocating buckling. Analogue modelling has been deployed to study the structural and surface expression of buckling of the continental lithosphere in order to evaluate its explanatory power as underlying mechanism for mountain building and basin development in intraplate settings such as the Iberian Peninsula.

The rheological stratification of the model lithosphere consists of a brittle upper crust, a ductile lower crust and a ductile upper mantle consistent with the interpretation of geophysical and geological data. Dry K-feldspar sand represents the brittle crust, while two different types of silicone mixture were used for the ductile crust and viscous upper mantle respectively, floating on a low viscosity, high density fluid corresponding to the experimental asthenosphere. Scaled velocities are in the order of 0.5 cm/h which correspond to 7mm/y for 20% of shortening assumed for whole Iberia. The experiments have been conducted within a Plexiglas tank under normal gravity conditions.

The experimental results show that the consequence to the velocity increase is that the strength of the ductile crust and upper ductile mantle increases, leading to an increase in fold wavelength(s). As a consequence upper crustal thrusts and pop-up structures are wider spaced in the case of high convergence rates suggesting that the process of folding exerts a primary control on spacing between the thrusts and the morphology of intra- and intermountain basins. Typically these basins get deformed by late thrusts, which sometimes do not reach the model surface but contribute to their uplift.

Inspired by the modelling results we propound that the current elevation observed in the Duero Basin (∼800m) is the result of folding and late-stage thrusting. At lithospheric-scale we suggest that intraplate deformation takes place by heterogeneous thickening of the lower crust and the formation of basement pop-ups at upper crustal level. These results are in agreement with available geological and geophysical data from the Duero Basin, Spanish Central System and Toledo Mountains. This supports the idea that the surface and Moho topography of Iberia may be explained by the process of lithospheric folding.