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Formation and inversion of extensional ramp-syncline basins with pre-kinematic salt layers. Experimental results and application to Iberian Mesozoic analogues

Maria Roma (1), Oriol Pla (1), Mireia Butillé (1), Eduard Roca (1), Oriol Ferrer (1,2)

(1) Centre Mixt d'Investigació GEOMODELS - Grup of Geodynamics and Basin Analysis. Departament de Geodinàmica i Geofísica, Facultat de Geologia, Universitat de Barcelona. Barcelona, Spain., (2) Fault Dynamics Research Group. Earth Sciences Department. Royal Holloway University of London. Egham, TW20 0EX, United Kingdom.

The widespread extensional deformation that took place during Jurassic to Cretaceous times in the Western Europe and north-Atlantic realm resulted in the formation of several rift systems. Some of the basins associated to these rifts show broad syncline-shapes filled by thick sedimentary successions deposited overlying a hyperextended crust (i.e. Parentis, Cameros, Organyà or Columbrets basins in Iberia). The development of these syncline basins has been associated to the slip of low-angle lithospheric-scale extensional faults with ramp/flat geometries. The shape and kinematics of such faults have been usually established using the architecture of syn-kinematic layers and assuming a complete coupling of the hangingwall rocks and a layer parallel flexural slip deformation mechanism. However almost all these basins include pre-kinematic Upper Triassic salt layers which undubtoufully acted as an effective detachment decoupling the structure of sub- and suprasalt units. The presence of this salt is denoted by the growth of salt structures as diapirs or salt walls at the edges of these basins where the overburden was thinner. During latest Cretaceous and Cenozoic these basins were partially inverted and often incorporated into thrust-and-fold belts as the Pyrenees . Contractional deformation resulted in the reactivation of major extensional faults and, above the salt, the squeezing of pre-existent salt structures. The pre-kinematic salt clearly acted again as as a major detachment decoupling the contractional deformation.

Using an experimental approach (scaled sand-box models) the aim of our research is threefold: 1) to determine the geometrical features of the hangingwall above a convex upwards ramp of a low angle extensional fault with and without pre-kinematic salt, and consequently; 2) to decipher the role played by a pre-kinematic viscous layer, such as salt, in the development of these syncline basins; and 3) to characterize the contractional deformation that took place in them during a later contractional inversion. To achieve this goal an experimental program including seven different sand-box models has been carried out.

The experimental results show that fault shape controls the geometry and the kinematic evolution of the ramp synclines formed on the hangingwall during extension and subsequent inversion. Regarding this, the experiments also demonstrate that the presence of a viscous layer changed significantly the kinematic of the basin developing two clearly different structural styles above and below the polymer. The kinematic of this basin during extension change dramatically when the silicone layer was depleted with the formation of primary welds. Since this moment model′s kinematic becomes similar to the models without silicone. During the inversion, models show that low shortening produced the contractional reactivation of the major fault arched and uplifted the basin. In this scenario, if salt is rather continuous, took place an incipient reactivation of the silicone layer as a contractional detachment. By contrast, high shortening produces the total inversion of the detachment faults and the pop-up of the extensional basin.

Finally, models are compared with different natural analogues from Iberia validating previous published interpretations or proposing new interpretations inferring the geometry of the major fault, specially if the presence of a salt interlayer in the deformed rocks is known or suspected.