THE EFFECT OF FORCES INDUCED BY (CRUSTAL) TOPOGRAPHY ON THE (PALEO) STRESS FIELD IN THE IBERIAN PENINSULA

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The present day stress field in the Iberian Peninsula is very well documented by a large number of earthquake focal mechanism solutions, borehole breakout data and kinematic indicators in quaternary sediments. We used the finite element method to model the first order trends in the intraplate stress field in the Iberian Peninsula. In a first approach, we modelled the stress field by applying boundary forces to the edges of the model. The orientation of the maximum horizontal compression (Shmax) for this model is in agreement with the observations, the local state of stress, however, is not. Similar models that have been applied to other regions were able to predict relative magnitudes and direction of the principal stresses, but could not reproduce absolute values and local states of stress. A better knowledge of the latter is required for the successful prediction of failure or fault-reactivation and for quantifying the effects of larger scale processes like plate-driving mechanisms on stresses and deformation in sedimentary basins. In a second approach, we took into account the stresses induced by lateral density variations (i.e. topography and crustal thickness variations). This allowed us to incorporate the ridge push force as an intraplate force rather than as a boundary force and to take into account buoyancy forces associated with continental margins. The results are in close agreement with the observations. The modelling indicates that the general present day stress field in Iberia is the resultant of predominantly ridge push force of the opening of the Atlantic and collisional forces to the southern plate boundary. Regional deviations of this general stress field can be explained in terms of (crustal) topography.

Widespread Cenozoic intraplate deformation in the interior of the Iberian Peninsula has recorded the nature of the Cenozoic stress field. A compilation of the numerous paleostress studies shows that the stress field changed rapidly in type, orientation and magnitude in response to the opening of the Atlantic Ocean that caused differential motion between Iberia, Africa and Eurasia. Superposition in time and place of the stresses that were transmitted from the active plate boundaries to the interior created locally varying stress fields in the Iberian Peninsula. Collision of Iberia with Eurasia generated a NNW-SSE direction for Shmax in Earliest Tertiary. This orientation rotated to N-S or NNE-SSW during Paleocene-Eocene. M. Miocene collision with Africa caused a stress field with Shmax oriented NNW-SSE. During the L. Miocene extension in the Valencia area adjusted the regional stress field significantly. From L. Pliocene to present Shmax is oriented NNW-SSE again.

This changing stress field is the result of changes in the distribution of active plate boundary processes. As shown for the present day stress field, forces induced by lateral density variations have to be incorporated in models of the Tertiary stress fields in the Peninsula. Therefore, the models have been linked to paleo-geographical reconstructions of the Iberian Peninsula and the western Mediterranean and for this purpose a first order approximation of paleo-topography has been compiled.