FINITE ELEMENT MODELLING OF TERTIARY TO PRESENT DAY STRESS FIELDS IN THE IBERIAN PENINSULA.

B. Andeweg*, G. De Vicente**, F. Beekman*, S.Cloetingh* and A. Muñoz Martin**
*Vrije Universiteit Amsterdam
**Universidad Complutense de Madrid
Bernd Andeweg, Vrije Universiteit Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands, tel: +31-20-4447353, fax: +31-20-6462457, e-mail: andb@geo.vu.nl

The stress field in the Iberian Peninsula from E. Tertiary onward is well documented by a large number of (paleo)-stress studies. These show that the intraplate stress field changed rapidly in type, orientation and magnitude in response to the differential motions between Iberia, Africa and Eurasia. Oblique collision with Eurasia, which started during L. Cretaceous, created a stress field with Shmax (maximum horizontal compression) oriented NNW-SSE rotating to NNE-SSW during Paleocene-Eocene, accompanied by major deformation in northern Iberia. The main deformation front was relocated to southern Iberia during M. Miocene and collision with Africa caused an uniaxial compression, with Shmax again NNW-SSE. The Valencia Trough opened east of the microplate and readjusted the stressfield during L. Miocene to extension in the Valencia area and to strike slip in the interior of the plate. Finally, from L. Pliocene to present, the ongoing convergence between Africa and Eurasia/Iberia reactivated the NNW-SSE compressional stress field.

We used the finite element method to model first order variations in the Iberian plate stress field. Previous models for 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 on stresses and deformation in sedimentary basins. In our model we accounted for lateral density variations (i.e. topography and crustal thickness variations), which also may produce substantial intraplate stresses. 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.

In a first approach, we modelled the stress fields for different timeslices in Tertiary to present day without including the lateral density variation effects. The orientations of maximum compression of these advanced models are in agreement with the observations, the local state of stress, however, is not.

When taking into account the stresses induced by lateral density variations in the model for the present day setting, the resultant stress field is in close agreement with observations (focal mechanism solutions, bore-hole breakout data and fault-slip data of quaternary faults). The direction of the collisional force exerted by Africa was established from several plate-motion reconstruction model, we deduced that the magnitude is in the order of 10-20 MPa.