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Space and time stress partitioning within an intraplate region: Tertiary compressive stress fields in eastern Iberia

C. L. Liesa, J. L. Simón
Universidad de Zaragoza, Spain (carluis@unizar.es / Fax: +34976761106)

Palaeostress evolution of intraplate regions undergoing different tectonic compressions involves long-term sequences of strictly non coeval stress fields (‘tectonic phases’), as well as complex interactions of coeval, overlapping stress fields. Relationships between two coeval independent compressions (caused by distinct combinations of tectonic forces) can be diverse. If space and time overlapping is complete, each material point in the area is submitted to a single stress state, which represents the tensorial sum of both stress systems (Ramsay, 1967). This seems not to be the general case; on the contrary, such composite tectonic settings usually show ‘stress partitioning’. In some cases, depending upon the intensity of tectonic forces and the efficiency of stress transmission, only partial space overlapping occurs, both stress fields being recorded in separate areas (‘space stress partitioning’). In other cases, roughly coeval compressions do not result in single biaxial compression but in apparent succession of alternating compressive events at near orthogonal directions (‘time stress partitioning’), controlled by either coupling/decoupling changes at plate and block boundaries or stress release and redistribution subsequent to fault development (Simón et al., 2005).

The Iberian Chain (eastern Spain), an intraplate region in which an extremely high variety of Tertiary compression directions have been recorded, is a good example for applying the former notions. A total of 1,523 horizontal σ_1 axes inferred at an outcrop scale from brittle structures (faults, stylolites, and shear and hybrid joints) have been compiled by Liesa (2000) in northeastern Spain. Then they have been submitted to a systematic analysis in order to characterize regional stress fields and their evolution. The procedure involves statistical computing of local stress directions, identifying and “filtering” stress deviations at outcrop to map scales, analysis of time relationships, and a probabilistic-statistical approach (Liesa and Simón, 2004) allowing the final discrimination of independent, far-field compressions.

The results suggest that a single stress field with multiple perturbations cannot explain the ensemble of compression directions inferred in the region. On the contrary, three main intraplate compressional stress fields have been distinguished: *Iberian* (average σ_1 trending NE-SW), *Pyrenean* (average σ_1 N to NNE), and *Betic s.l.* (average σ_1 NW-SE). Moreover, three successive stages, showing a progressive clockwise rotation of σ_1 directions (ESE, SE and SSE, respectively), have been differentiated into the *Betic s.l.* compression. These stress fields (*Iberian, Betic, Pyrenean*), each one including local and regional deviations, were partially superposed in time and space, being driven by distinct combinations of far-field tectonic forces. The *Pyrenean* and *Betic* stress fields were mainly transmitted from the northern and southern boundaries, respectively, of the Iberian plate, and related to the convergence with Eurasia and Africa. The *Iberian* stress field essentially resulted from combination of collissional forces at the Pyrenean margin and the push force of the Atlantic plate. Each stress field was specially intense in a particular region (Pyrenees, Betic and Iberian chain) and a particular time (Oligocene-Miocene, middle-late Miocene and Eocene-Oligocene, respectively). Nevertheless, they were partially superposed in space and time in the whole northeastern Iberian peninsula. The spatial distribution of local stress states allow us to recognise stress deviations on a variety of scales, from a few metres to several hundred kilometres. However, deviations of stress trajectories usually were less than 10-15° from the average σ_1 regional trajectories of each stress field.

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