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3-D strain distribution in the Ibero-Armorican Arc: a review

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ABSTRACT

Keywords: 3D strain geometry; Ibero-Armorican Arc; Variscides; suture; obduction; subduction; collision; fabric; symmetry.

The Ibero-Armorican Arc (IAA), best displayed in NW Iberia, is due to dextral transpressive shearing between Laurussia and Gondwana. A promontory of Gondwana is deformed by subduction followed by continental collision processes. The IAA shows variable stretching, parallel to the Arc in the outer part of the arc and almost perpendicular to it and parallel to centripetal nappe transport in the inner part. This pattern is due to secondary arcuation imprinted in primary arcuation. Centripetal nappe transport to the SE, in present geographical coordinates produces monoclinic structures at all scales that obliterate earlier arc parallel stretching in the allochthonous units. The arc parallel stretching is less curved than the major earliest structures in the autochthon. This fact shows that this stretching was produced in the root zone of the NW Iberia allochthons before their emplacement at present location. Minor secondary shear to the N, in the lower allochthon of the Iberian segment of IAA, grades to coaxial stretching producing orthorhombic micro and meso fabrics at the zone of maximum curvature of the lineation in the highest nappe; these relationships suggest that the schizosphere is dragged by the plastosphere because the sense of nappe transport direction to SE has a component which is opposed to the minor shear component to the N of the triclinic fabrics.

In Iberia the dextral component is concentrated in the Porto-Tomar-Ferreira do Alentejo transform that limits the antithetic left-lateral regime to the East. It remains to be proved what is the polarity of subduction in Paleotethys in order to generate the presently observed structure.

The Ibero-Armorican Arc (IAA), best displayed in NW Iberia, is due to dextral transpressive shearing between Laurussia and Gondwana (Peréz-Estaún *et al.*, 1988; Ribeiro *et al.*, 1995). A promontory of Gondwana is deformed by subduction (Ribeiro, 1974) followed by continental collision processes (Dias & Ribeiro, 1995). The IAA shows variable stretching, parallel to the Arc in the outer arc and almost perpendicular to it and parallel to centripetal nappe transport in the inner arc (Ribeiro, 1974; Matte & Ribeiro, 1975; Ries & Shackleton, 1976). This pattern is due to secondary arcuation imprinted in primary arcuation. Centripetal nappe transport to the SE, in present geographical coordinates (Marques *et al.*, 1992) produces monoclinic structures at all scales that obliterate earlier arc parallel stretching (Llana-Fúnez & Marcos, 2002) in the allochthonous units. The arc parallel stretching is less curved than the major earliest structures in the autochthon. This fact shows that this stretching was produced in the root zone of the NW Iberia allochthons before their emplacement at present location. Minor secondary shear to the N (Llana-Fúnez, 2002), in the lower allochthon of the Iberian segment of IAA, grades to coaxial stretching producing orthorhombic micro and meso fabrics at the zone of maximum curvature of the lineation in the highest nappe (Fernandez, 1993); these relationships suggests that the schizosphere is dragged by the plastosphere because the sense of nappe transport direction to SE has a component which is opposed to the minor shear component to the N of the triclinic fabrics.

This hypothesis can be tested by comparing the sense and amount of minor secondary shear of triclinic fabrics in the Iberian and Armorican segments of the IAA; this may contribute to solve, by direct observation of the deep structure of an eroded ancient orogen, a problem raised by the kinematics of active orogens that can only be addressed by indirect seismic imaging and inferences from geodetic monitoring at the surface (Ribeiro, 2002).

The IAA is a congruent kinematics structure that develops in successive stages expressed by variations in main nappe transport direction and sense both in space and in time. During the obduction-subduction stage the arc was less curved and the transport direction in the emplacement of the Paleotethys ophiolite over the Iberian Terrane had already a component of dextral slip.

During the collision stage there is out-of-sequence emplacement of high grade metamorphic units, polyorogenic and/or polycyclic, above the obducted ophiolite but also emplacement of forward propagation sequence of complex thrust units below the ophiolite; these comprise, from top to bottom, far-traveled allochthonous complex with high pressure Variscan metamorphism, para-autochthonous complexes with paleogeographic affinities with the Central Iberian Zone (CIZ) on top of the CIZ autochthon. The collision related transport direction is to SSE in upper units and rotates to SE as we move downwards in the nappe pile.

As collision proceeds there is a migration of orogeny to the more external zones to the E and thrusting affects higher crustal levels; the transport direction becomes to the E. We interpret this kinematic variations as a consequence of dextral component of transpresssion in the southern branch of the IAA, with the movement in the higher level external zones reflecting more closely the vector plate movement to the E. This results in a constriction at the core of the Arc, showed by longitudinal and radial folds in the Cantabrian Zone (Julivert & Marcos, 1973) above a major cover décollement of the Precambrian basement.

In Iberia the dextral component is mostly concentrated in the N-S Porto-Tomar-Ferreira do Alentejo transform connecting the SW and NW sutures (Martínez-Catalán, 1990; Dias & Ribeiro, 1993; Fonseca *et al*., 1999; Chaminé, 2000; Rosas, 2003; Fernandez *et al*., 2003); the conjugate NW-SE to W-E sinistral system is distributed through the Iberian segment of the IAA, antithetic to the main synthetic dextral W_E component in Armorica.

All the previous tectonic evolution can be explained by a model of progressive arc development with both primary and secondary components; an early promontory of cratonic Gondwana delineates an irregular passive margin that is further tightened during the obduction-subduction stage and finally by oblique collision between Laurrusia and Gondwana (Dias & Ribeiro, 1995; Llana-Fúnez & Marcos, 2002); an orogenic wedge to the W, formed by subduction, obduction and collision processes between Iberia and Avalonia by closure of Paleotethys is finally transported over Iberia.

It remains to be proved whether this evolution is due to persistent W directed subduction (Matte, 2001; Martinez-Catalán *et al*., 1997) or E directed subduction with antithetic obduction and collision generating a flake geometry (Ribeiro, *et al*., 1990; Dias & Ribeiro, 1995; Rosas, 2003).

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