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Strike-slip shear zones of the Iberian Massif: Are they coeval?

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ABSTRACT

Strike-slip shear zones of the Variscan orogen are used to derive the evolution of paleostrain and discuss the kinematics of the waning stages of the Gondwana-Laurussia collision during the amalgamation of Pangea. In the Iberian Massif, the recognition of three late Carboniferous deformation events related to strike-slip tectonics (D_3, D_4, D_5) in the Trancoso-Pinhel region (Portugal) reveals that late orogenic transcurrent deformation was episodic and occurred in a short period of time (<15 m.y.). Early stages of strike-slip deformation included dextral and sinistral shear zones and orogen-parallel upright folds (D_3; ca. 311 Ma). These structures followed the development of extensional shear zones (D_2) during the tectonothermal reequilibration of the orogen. D_3 structures were deflected and folded by the sinistral D_4 Juzbado-Penalva do Castelo shear zone, dated as ca. 309–305 Ma by SHRIMP (sensitive high-resolution ion microprobe) U-Pb zircon dating of synkinematic granitoids. D_3 and D_4 structures were folded under east-west compression (D_5) influenced by the strike-slip movement of the dextral Porto-Tomar shear zone. Variscan movement along the Porto-Tomar shear zone started ca. 304 Ma (onset of the Buçaco basin and syn-D_5 granites), but ceased before ca. 295 Ma (age of the final closure of the Ibero-Armorican arc and crosscutting granites). The contrasting geometry, kinematics, and timing of these strike-slip shear zones are explained by deformation partitioning upon a rheologically inhomogeneous crust with structural and tectonothermal anisotropies generated during previous deformation. The convergence vector between Gondwana and Laurussia during D_3–D_5 remained the same, and was equivalent to the vector that explains the previous tectonic record (D_2) in central and northwestern Iberia.

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INTRODUCTION

Structures with contrasting geometry and kinematics can be (1) the result of a single phase of deformation operating differently from one place to the other due to, e.g., local variations of finite strain, strain vorticity, thermal conditions, rheological rock properties, and presence of fluids; (2) independent from each other and derive from different phases of deformation; or (3) the result of progressive deformation associated with gradual changes of pressure-temperature conditions, e.g., emplacement and cooling of a syntectonic granitoid (e.g., Carreras et al., 2004). Distinguishing between these three scenarios is challenging when the structures under consideration share geometrical properties, and/or when the time period for their development is shorter than the time resolution of absolute dating methods. Establishing the geometry and timing for structures formed during orogeny is key to reconstructing the associated convergence and/or divergence and evolution. Inferences about evolving paleostrain can help to build tectonic models for orogens where significant parts of the paleogeographic references are modified, such as in the case of Paleozoic orogens that are now dispersed over different tectonic plates. Therefore, identifying the full sequence of structures in a given region is a fundamental step toward reconstructions of large-scale tectonic settings.

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Strike-slip shear zones are common in orogenic systems, and are considered one of the tools to determine relative plate movements (e.g., Shelley and Bossière, 2002). Block extrusion or escape tectonics may produce conjugated faults (e.g., Tapponnier and Molnar, 1979; Tapponnier et al., 1982), so using a suitable general picture, including timing and fault trace, is advised for producing tectonic models based on the study of strike-slip shear zones. Here we provide a case study of the complexity regarding the structural evolution, kinematic interpretation at the scale of the orogen, and dating of strike-slip shear zones formed in a collisional orogen. In the Variscan orogen, some major geotectonic domains are bounded by strike-slip shear zones (Fig. 1). Defining their kinematics and timing beyond the limits of analytical methods is thus necessary to better understand the processes involved in the building of long-lived orogenic systems such as the Variscan. The strike-slip shear zones analyzed here formed at an advanced stage in the late Paleozoic collision of Gondwana and Laurussia, and therefore provide a closer view into the kinematics and finite strain during the final amalgamation of Pangea.

In the Iberian Massif of the Variscan orogenic system, strike-slip shear zones and upright folds are considered the result of deformation partitioning in a transpressional regime. However, the timing for transpression has been assigned to contrasting periods in the Variscan orogeny (e.g., Iglesias Ponce de Leon and Choukroune, 1980; Dias and Ribeiro, 1998; Dias et al., 2010, 2013; Díez Fernández and Martínez Catalán, 2012; Martínez Catalán, 2012). The debate is centered on orogen-parallel upright folds accompanying the strike-slip shear zones. Were they developed during the

