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Extensional orogenic collapse captured by strike-slip tectonics: Constraints from structural geology and U—Pb geochronology of the Pinhel shear zone (Variscan orogen, Iberian Massif)

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ABSTRACT

The late Paleozoic collision between Gondwana and Laurussia resulted in the polyphase deformation and magmatism that characterizes the Iberian Massif of the Variscan orogen. In the Central Iberian Zone, initial continental thickening (D_1; folding and thrusting) was followed by extensional orogenic collapse (D_2) responsible for the exhumation of high-grade rocks coeval to the emplacement of granitoids.

This study presents a tectonometamorphic analysis of the Trancoso-Pinhel region (Central Iberian Zone) to explain the processes in place during the transition from an extension-dominated state (D_2) to a compression-dominated one (D_3). We reveal the existence of low-dipping D_2 extensional structures later affected by several pulses of subhorizontal shortening, each of them typified by upright folds and strike-slip shearing (D_3, D_4 and D_5, as identified by superimposition of structures). The D_2 Pinhel extensional shear zone separates a low-grade domain from an underlying high-grade domain, and it contributed to the thermal reequilibration of the orogen by facilitating heat advection from lower parts of the crust, crustal thinning, decompression melting, and magma intrusion. Progressive lessening of the gravitational disequilibrium carried out by this D_2 shear zone led to a switch from subhorizontal extension to compression and the eventual cessation and capture of the Pinhel shear zone by strike-slip tectonics during renewed crustal shortening. High-grade domains of the Pinhel shear zone were folded together with low-grade domains to define the current upright folded structure of the Trancoso-Pinhel region, the D_3 Tamames-Marofa-Sátão synform. New dating of syn-orogenic granitoids (SHRIMP U—Pb zircon dating) intruding the Pinhel shear zone, together with the already published ages of early extensional fabrics constrain the functioning of this shear zone to ca. 331–311 Ma, with maximum tectonomagmatic activity at ca. 321–317 Ma. The capture and apparent cessation of movement of the Pinhel shear zone occurred at ca. 317–311 Ma.

1. Introduction

Superimposition of contractional and extensional structures is widely observed at different scales in ancient orogenic belts and modern analogues that experienced thickening followed by extensional collapse (Aerden and Malavieille, 1999; Vanderhaeghe et al., 1999; Vanderhaeghe, 2012; Rabin et al., 2015; Scheffer et al., 2016). The extensional collapse of orogenic belts provides a partial explanation for the return of orogenic large crustal thicknesses to normal without very much erosional denudation, with the preservation of supracrustal sequences, high temperature metamorphic assemblages and partial melting of continental crust (Dewey, 1988).

The integration of superimposed structures in a comprehensive tectonic-geodynamic model is not direct, and attributing structures to construction or collapse of the orogenic belt is not always straightforward. Discussing the relationships between tectonics and geodynamics on recent orogenic belts, with better-constrained plate-scale reconstructions, is easier than for old orogenic belts such as the Variscan, where the plate-scale kinematic framework is less constrained and needs to be inferred. In the earliest tectonic models of the Variscan orogen in the Iberian Massif it was proposed that all structures were formed by regional horizontal contraction in the course of the late Paleozoic collision of Gondwana and Laurussia (Ribeiro et al., 1990; Quesada et al., 1994). Later on, were recognized in the Iberian Massif shallow-dipping shear zones formed after initial crustal thickening produced by early folds and thrusts. Such extensional shear zones are related to exhumation of high-grade metamorphic rocks and were developed in the presence of melt. These shear zones account for vertical crustal thinning along

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