Tectonophysics 558-559 (2012) 28–44

Contents lists available at SciVerse ScienceDirect

Tectonophysics

journal homepage: www.elsevier.com/locate/tecto

Early carboniferous wrenching, exhumation of high-grade metamorphic rocks and basin instability in SW Iberia: Constraints derived from structural geology and U–Pb and ^{40}Ar–^{39}Ar geochronology

M. Francisco Pereira [a,*], Martim Chichorro [b], J. Brandão Silva [c], Berta Ordóñez-Casado [d], James K.W. Lee [e], Ian S. Williams [f]

[a] Instituto Dom Luiz, Departamento de Geociências, Escola de Ciência e Tecnologia, Universidade de Évora, Apartado 94, 7001-554 Évora, Portugal
[b] CICEGe, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Quinta da Torre, 2829-516 Caparica, Portugal
[c] Instituto Dom Luiz, Departamento de Geologia, Faculdade de Ciências, Universidade de Lisboa, Edificio C3, Campo Grande, Lisboa, Portugal
[d] Departamento de Geología, Universidad de Oviedo, 33005, Oviedo, Asturias, Spain
[e] Department of Geological Sciences and Geological Engineering, Queen´s University, Kingston, Ontario, Canada, K7L 3N6
[f] Research School of Earth Sciences, The Australian National University, Canberra, ACT, 0200, Australia

ARTICLE INFO

Article history:
Received 16 January 2012
Received in revised form 4 June 2012
Accepted 14 June 2012
Available online 23 June 2012

Keywords:
Variscan belt
Wrench tectonics
Timing of deformation
Basin instability
Ossa-Morena Zone
South Portuguese Zone

ABSTRACT

New U–Pb and ^{40}Ar–^{39}Ar geochronology and structural data from high- to medium grade metamorphic shear zones of the Ossa-Morena Zone, and structural data from Early Carboniferous basins (Ossa-Morena Zone and South-Portuguese Zone), place additional constraints on the Variscan tectonics in SW Iberia. A zircon U–Pb age of 465±14 Ma (Middle Ordovician) measured on migmatite from the Coimbra–Cordoba shear zone is interpreted as the age of protolith crystallization. This age determination revises the information contained in the geological map of Portugal, in which these rocks were considered to be Proterozoic in age.

This paper describes the evolution of Variscan wrench tectonics related to the development of shear zones, exhumation of deep crustal rocks and emplacement of magma in the Ossa-Morena Zone basement. In the Coimbra–Cordoba shear zone (transpressional), migmatites were rapidly exhumed from a depth of 42.5 km to 16.6 km over a period of ca. 10 Ma in the Viséan (ca. 340–330 Ma), indicating oblique slip exhumation rates of 8.5 to 10.6 mm/yr (Campo Maior migmatites) and 3.2 mm/yr (Ouguela gneisses) respectively. In the Évora Massif, the gneisses of the Boa Fé shear zone (transtensional) were exhumed from 18.5 to 7.4 km depth in the period ca. 344–334 Ma (Viséan), with exhumation oblique slip rates of 2.8 to 4.2 mm/yr. At the same time, the Early Carboniferous basins of SW Iberia were filled by turbidites and olistoliths, composed mostly of Devonian rocks. The presence of olistoliths indicates significant tectonic instability during sedimentation with large-scale mass movement, probably in the form of gravity slides. Deformation and metamorphism dated at 356±12 Ma, 321±13 Ma and 322±29 Ma respectively suggests that Variscan wrench movements were active in SW Iberia during the Early Carboniferous for a period of at least 35 Ma.

1. Introduction

Intra-continental deformation and metamorphism related to crustal thinning, exhumation of deep crustal rocks, and basin formation during the terminal stages of, and immediately after, continental collision, are features of ancient and modern orogenic belts. In many cases these processes are associated with large-scale wrench tectonics, producing shear zones in the crystalline basement. These areas of crustal weakness are characterized by strong ductile deformation, commonly associated with rapid exhumation of medium- to high-pressure metamorphic rocks (Sandiford and Powell, 1986). The movement that occurs in these basement ductile shear zones commonly coincides with the progressive evolution of synorogenic basins and gravitational instability (Rey et al., 2001). SW Iberia represents an ideal case study to understand how the exhumation of the deep portions of an orogenic belt interacts with subsiding areas and synorogenic basin evolution is the subject of this study. Following the formation and erosion of the Cadomian magmatic arc in the Neoproterozoic (Pereira et al., 2006a, 2008a, 2011, in press), Cambrian intra-continental rifting in SW Iberia (Sanchez-Garcia et al., 2003, 2008, 2010) led to the opening of the Rheic Ocean through the Ordovician–Silurian and Lower Devonian (Linnemann et al., 2008; Robardet and Gutierrez-Marco, 1990). The later closure of the Rheic Ocean and subsequent collision between Gondwana and Laurussia, which ultimately led to the complex amalgamation of Pangaea, gave rise to the Western and Central European Variscan belt (Matte, 2001), in which SW Iberia is now located (Martinez Catalan et al.,

* Corresponding author.
E-mail address: mpereira@uevora.pt (M.F. Pereira).

0040-1951/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.tecto.2012.06.020