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Time-space distribution of silicic plutonism in a gneiss dome of the Iberian Variscan Belt: The Évora Massif (Ossa-Morena Zone, Portugal)

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ABSTRACT

In the Iberian Variscan Belt, polyphasic deformation has been recognized as comprising an early phase of crustal thickening, followed by an intermediate phase of crustal extension and doming, and a later phase of shortening. The Évora Massif is a gneiss dome of the westernmost domains of the Ossa-Morena Zone (SW Iberia), which provides a remarkable insight into the late Paleozoic deep crustal structure of the Variscan continental crust of northern Gondwana. In this study, we bring new structural and geochronological U-Pb data for the northern hanging-wall of the Évora Massif. We describe the existence of low-dipping D_2 extensional shear zones associated with Buchan-type metamorphism (M_2); this enables three tectono-metamorphic units to be distinguished: the Lower Gneiss Unit, the Intermediate Schist Unit, and the Upper Slate Unit. D_2-M_2 structures experienced sub-horizontal shortening (D_3) and were transposed by low-plunging folding, thrusting and strike-slip faulting. Zircon grains extracted from Pavia quartz-feldspathic gneiss of the Lower Gneiss Unit yielded a crystallization age of ca. 521 Ma (Cambrian Stage 2–3), which establishes a correlation with tectono-metamorphic units of the footwall and southern hanging-wall of the Évora Massif. U-Pb zircon dating of Divôr foliated quartz-diorite (339 ± 7 Ma), Malarranha weakly foliated biotite-rich granite (322 ± 3 Ma), and undeformed porphyritic granite of the Pavia pluton (314 ± 4 Ma) constrain the timing of emplacement of granitic magmas synchronously with doming. Carboniferous magmatism initiated with doming (ME_1 - ca. 343–335 Ma), continued through D_2-M_2 (ME_2 - ca. 328–319 Ma), and lasted until the waning stage of crustal extension (ME_3 - ca. 317–313 Ma). The Évora Massif gneiss dome probably formed as result of the combined effect of gravitational collapse of the thickened crust and buoyancy-driven gravitational instability developed in the partially molten continental crust influenced by the transfer of heat from rising mantle-derived (i.e. dioritic-gabbroic) magmas rocks found in the footwall of the Évora Massif.

1. Introduction

Gneiss domes are large-scale geological structures representing the thermal and structural record of the flow of partially molten crust during the formation of mountain belts (Vanderhaeghe and Teyssier, 2001; Teyssier and Whintney, 2002). Crustal flow and gneiss dome formation may occur in both contractional and extensional settings (Yin, 2004). Gneiss domes (Eskola, 1948) occur at the footwall extensional detachments characterized by strong ductile deformation and a sudden increase in the temperature of metamorphism approaching the footwall block (Vanderhaeghe and Teyssier, 1997; Yin, 2004; Stübner et al., 2013). Continent-continent collision and significant crustal thickening at the boundaries of colliding plates are commonly accompanied and/or followed by extension. It is accepted that gneiss domes may be formed during crustal extension associated with the gravitational collapse of a mountain range, simultaneously with or immediately after an episode of crustal thickening (Coney and Harms, 1984; Dewey, 1988; Ratschbacher et al., 1989; Vanderhaeghe et al., 1999; Vanderhaeghe and Teyssier, 2001; Rey et al., 2001; Harris et al., 2002; Houseman and Gemmer, 2007; Whitney et al., 2007). The collapse leads to the exhumation and adiabatic decompression of hot thickened crust. Ductile deformation during crustal extension is enhanced by the heat input from early plutons, sills, or dikes, causing doming and exhumation of higher-grade metamorphic rocks (Lister and Baldwin, 1993). Subsequently to extension, a switch to a later contractional event, related to the same mountain-forming process, may also occur during the progressive convergence of continental blocks. This later contraction may be an additional driving force for the differential uplift of gneiss domes and the intrusion of later plutons. As a result of the switch to compression, low-angle extensional shear zones,

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