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Research Article

Atypical peri-Gondwanan granodiorite–tonalite magmatism from Southern Iberia. Origin of magmas and implications

Antonio Castro [a,b,*], Manuel F. Pereira [c], Carmen Rodríguez [d], Carlos Fernández [e], Jesús D. de la Rosa [e]

[a] Instituto de Geociencias (IGEO), Consejo Superior de Investigaciones Científicas - Universidad Complutense de Madrid (CSIC-UCM), Ciudad Universitaria, 28040 Madrid, Spain
[b] Instituto Andaluz de Ciencias de la Tierra (IACT), Consejo Superior de Investigaciones Científicas - Universidad de Granada (CSIC-UGR), 18100 Armilla, Granada, Spain
[c] Instituto de Ciências da Terra (ICT), Departamento de Geociências, Escola de Ciências e Tecnologia (ECT), Universidade de Évora, Évora, Portugal
[d] Geosciences Barcelona, Consejo Superior de Investigaciones Científicas (CSIC), Bardelona, Spain
[e] Departamento de Ciencias de la Tierra, Universidad de Huelva, Spain

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ABSTRACT

An ensemble of fifteen granodiorite/tonalite plutons and minor intrusions was generated during Cambro-Ordovician times (ca. 498–462 Ma) at the margin of Gondwana, which occupies a large portion of the Central Iberian Zone of the Iberian Massif (Spain and Portugal). This ensemble is known as the Beira-Extremadura batholith (BEB), which is mainly composed of tonalities and granodiorites (>90 vol%) and shows an atypical composition, with values of ASI (alumina saturation index) ≈ 1.2 on average, and marked calc-alkaline affinity in terms of major and trace elements. SHRIMP zircon U-Pb ages of 476 ± 7 Ma, 476 ± 6 Ma, and 474 ± 7 Ma for Montánchez, Santa Cruz de la Sierra and Valdemorales tonalites, respectively, coincide within uncertainty with the age of other Lower Ordovician BEB intrusions. Analysis of phase relations and comparisons with experimental results on cotectic liquid compositions, indicate that these atypical rocks represent calc-alkaline magmas that carried exogenous pelitic restites from depth. Assimilation of partially molten metasediments by invasion of calc-alkaline magmas is a plausible explanation. Model mixing of experimental calc-alkaline liquids and Ediacaran metasedimentary rocks yields that 20% (up to 40% in samples of the Santa Cruz Pluton) of assimilated metagreywackes and metapelites is required to account for geochemical atypical compositions departing from a main cotectic array of calc-alkaline systems. The processes of melting or melting plus assimilation are favored by addition of water-rich fluids. We propose a tectonic scenario of crustal extension and metasomatized mantle melting that supplied hydrous intermediate magmas to the crust triggering crustal melting and massive assimilation of metasediments.

1. Introduction

Significant advances in unravelling ancient orogenic processes and diverse geodynamic scenarios have been produced using geochemical data from granitic rocks since Pitcher (1982) related tectonic regimes to granite types. Anatectic peraluminous leucogranites (S-type; Chappell and White, 1974) are characteristic of collisional orogens, while calc-alkaline granite–tonalite–Qz-diorite associations of infracrustal origin (I-type; *op. cit.*) are mostly related to Andean-type margins (I-Cordilleran) and post-collisional uplift (I-Caledonian) (Chappell and Stephens, 1988). A dual origin as primary (fractionated from diorites) and secondary (melting of lower crust) has been proposed for these two categories of I-type granites (Castro, 2020). However, granites cannot always be classified unambiguously in one of the known great categories (S, I, M), and transitional types can often be found in particular settings. Thus, special attention must be paid to interpretations of tectonic implications.

We report here a case of Lower Ordovician atypical granodiorites and tonalites from the Iberian massif (Spain and Portugal) that share S- and I-type features, of which origin is not well constrained. Atypical granitic rocks crop out in several plutons aligned over more than 300 km in the Central Iberian Zone (CIZ) forming the Cambro–Ordovician Beira-Extremadura batholith (BEB). These plutons represent voluminous magma generation involving particular sources and/or processes that affected a large section of the continental crust. The study the origin of these compositionally atypical magmatic rocks may help to understand the tectonic scenario of crustal growth and reworking in Iberia during the Lower Paleozoic. Similar atypical granitic rocks were described as "S-type tonalites" in the Cenozoic Hidaka metamorphic belt of Hokkaido (Japan) (Jahn et al., 2014; Kemp et al., 2007; Shimura et al., 2004) and as transitional S/I-type granodiorites in the Lower

* Corresponding author at: Instituto Andaluz de Ciencias de la Tierra (IACT), Consejo Superior de Investigaciones Científicas - Universidad de Granada (CSIC-UGR), 18100 Armilla, Granada, Spain.
E-mail address: antonio.castro@csic.es (A. Castro).

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