Gondwana Research 106 (2022) 164–173

Contents lists available at ScienceDirect

Gondwana Research

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

The unique Cambro-Ordovician silicic large igneous province of NW Gondwana: Catastrophic melting of a thinned crust

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ARTICLE INFO

Article history:
Received 16 July 2021
Revised 20 December 2021
Accepted 23 January 2022
Available online 29 January 2022
Handling Editor: R.D. Nance

Keywords:
Cambro-Ordovician magmatism
Ollo de Sapo Formation
Data-analysis
Geochemical modelling
Extensive crustal melting

ABSTRACT

Cambro–Ordovician silicic magmatism in the Central Iberian Zone of the Iberian Massif (Ollo de Sapo Formation, OSF) constitutes a voluminous and geochemically atypical magmatic event that formed preceding the breakup of the northern margin of Gondwana. To date, and due to uncommon geochemical signatures, such as a high Fe, Mg content compared to anatectic melts and the departing from the calc-alkaline trends, the origin of such magmatic event is not fully understood. Herein, we report a data-analysis of geochemistry linking magmas and source compositions. The analysis of the combined data from multiple studies ascribes the geochemistry of the OSF rocks to a combination of extensive melting of Ediacaran metasiliciclastic rocks and a Ca-rich component. It is hypothesized that fluids released by crystallization of mafic magmas contributed to partial melting of a thick metasedimentary pile represented by Ediacaran siliciclastic rocks. Such melting event gave rise to a mobile nebulite or *migma*, which was able to extrude and form the super-eruption or "flare-up" that characterizes Cambro-Ordovician silicic magmatism at the Gondwana margin. Fast, catastrophic crustal melting with large-scale restite entrainment, triggered by the influx of mafic magma-derived fluids, are considered the main cause of the unique features of this Cambro-Ordovician atypical silicic large igneous province of Gondwana.

1. Introduction

The Cambro–Ordovician magmatic rocks, known as the Ollo de Sapo Formation (OSF) in the Iberian Massif, form thick piles (up to 2 km in Sanabria) of volcanic, subvolcanic and plutonic successions, along hundreds of km of lineaments, in the Central-Iberian Zone (Díez-Montes et al., 2010; Fernandez et al., 2008; Montero et al., 2009). They represent correlatives of numerous small outcrops of magmatic rocks distributed along the European Variscan belt (García-Arias et al., 2018 for review) and equivalent formations in the Famatina magmatic belt in South America (Nance, 2010; Nance et al., 2010). Thus, a global-scale episode of voluminous silicic magmatism, with the category of a large igneous province (LIP), was developed at the Gondwana supercontinent margin along a short period of 30 My from ca. 500 to 470 Ma (e.g., Díaz-Alvarado et al., 2016; Montero et al., 2007; Rubio-Ordóñez et al., 2012).

Whole-rock geochemistry of this Cambro-Ordovician magmatic event reveals unique features that have not been encountered so far in the geological record, and whose causes remain unknown. Here we present a reinterpretation of petrological features and data-analysis using geochemical and experimental databases to shed light on the origin of magmas and the confluent phenomena that were determinant for its unique magmatic compositions. The interest is two-fold: (1) determination of mechanisms of magma generation will help to constrain the tectonic setting with consequences on plate reconstructions of the Gondwana supercontinent; and (2) assessment of crustal recycling versus new crust addition can be better understood through the analysis of such silicic large igneous provinces, in which, voluminous magmatism was concentrated over a short time period. This study is focused on the Cambro–Ordovician magmatism of the Central-Iberian Zone representing the basement of Gondwana and preceding the breakup of northern margin of the Gondwana supercontinent, where large

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https://doi.org/10.1016/j.gr.2022.01.011
1342-937X/