Tectonophysics 681 (2016) 15–30

Contents lists available at ScienceDirect

Tectonophysics

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

Geochemistry of the Ediacaran–Early Cambrian transition in Central Iberia: Tectonic setting and isotopic sources

José Manuel Fuenlabrada [a,*], Agustín P. Pieren [b], Rubén Díez Fernández [c], Sonia Sánchez Martínez [c], Ricardo Arenas [c]

[a] CAI de Geocronología y Geoquímica Isotópica, Universidad Complutense, 28040 Madrid, Spain
[b] Departamento de Estratigrafía, Universidad Complutense, 28040 Madrid, Spain
[c] Departamento de Petrología y Geoquímica e Instituto de Geociencias (UCM, CSIC), Universidad Complutense, 28040 Madrid, Spain

ARTICLE INFO

Article history:
Received 4 August 2015
Received in revised form 12 November 2015
Accepted 18 November 2015
Available online 26 November 2015

Keywords:
Ediacaran-Cambrian transition
Whole-rock geochemistry
Sedimentary rocks
Sm-Nd isotope geochemistry
Iberian Massif

ABSTRACT

A complete Ediacaran–Early Cambrian stratigraphic transition can be observed in the southern part of the Central Iberian Zone (Iberian Massif). Two different stratigraphic units, underlying Ordovician series, display geochemical and Sm–Nd isotopic features in agreement with an evolving geodynamic setting. Pusa Shales (Early Cambrian) rest unconformably on greywackes of the Lower Alcudian Formation (Late Ediacaran). Both sequences present minor compositional variations for major and trace element contents and similar REE patterns, close to those of PAAS (Post Archean Australian Shale). Trace element contents and element ratios suggest mixed sources, with intermediate to felsic igneous contributions for both units. Tectonic setting discrimination diagrams for the Ediacaran greywackes indicate that these turbiditic series were deposited in a sedimentary basin associated with a mature active margin (volcanic arc). However, the compositions of the Cambrian shales fit better with a more stable context, a back-arc or retro-arc setting. $\varepsilon Nd_{(T)}$ and TDM ages are compatible with dominance of a similar cratonic source for both sequences, probably the West Africa Craton. εNd_{565} values for the Ediacaran greywackes (−3.0 to −1.4) along with TDM ages (1256–1334 Ma) imply a significant contribution of juvenile material, probably derived from the erosion of the volcanic arc. However, εNd_{530} values in the Cambrian shales (−5.2 to −4.0) together with older TDM ages (1444–1657 Ma), suggest a higher contribution of cratonic isotopic sources, probably derived from erosion of the adjacent mainland. Coeval with the progressive cessation of arc volcanism along the peri-Gondwanan realm during the Cambrian, there was a period of more tectonic stability and increasing arrival of sediments from cratonic areas. The geochemistry of the Ediacaran–Cambrian transition in Central Iberia documents a tectonic switch in the periphery of Gondwana, from an active margin to a more stable context related to the onset of a passive margin.

1. Introduction

Geochemical composition and isotopic characteristics of fine-grained clastic rocks have proved to be a reliable record of continental crust evolution, and therefore are a useful indicator of the origin and tectonic setting in which sedimentation took place (Condie, 1993; McLennan et al., 1990; Taylor and McLennan, 1985). The relative absence of REE fractionation during depositional processes has allowed the use of Sm–Nd data to discriminate between sources, providing information about the paleogeography of sedimentary basins as indicated by the juvenile or more evolved character of their sediment infill (Murphy and Nance, 2002).

Over the last few years, we have focused our work on using whole-rock geochemistry and Sm–Nd isotopic features of metasedimentary series in the Iberian Massif as a potential mean of shedding light on the dynamic evolution of the peri-Gondwanan arc system and to reconstruct the paleogeography of this domain during Ediacaran–Early Paleozoic times. Geochemical features and Nd model ages of metasedimentary rocks from the allochthonous complexes of NW Iberia postulated an arc-derived provenance for the metagreywackes exposed in the Órdenes Complex (Upper Units) (Albert et al., 2015; Fuenlabrada et al., 2010), whereas older TDM ages obtained from metagreywackes and metapelites of the Basal Units pointed to a back-arc or retro-arc basin located in the interior of the continental domain (Díez Fernández et al., 2010, 2012; Fuenlabrada et al., 2012).

Ediacaran–Early Cambrian rocks crop out extensively in the Central Iberian Zone (Iberian Massif). These sequences are affected by low-grade metamorphism and exhibit a gradual and complete transition between both periods. The Central Iberian Zone (CIZ) has been a source of discussion on the provenance and tectonic settings of its Neoproterozoic

* Corresponding author at: CAI de Geocronología y Geoquímica Isotópica Facultad de Ciencias Geológicas Universidad Complutense de Madrid Calle José Antonio Novais, 12 28040, Madrid España.
E-mail address: jmfuenla@ucm.es (J.M. Fuenlabrada).

http://dx.doi.org/10.1016/j.tecto.2015.11.013
0040-1951/

and Cambrian sequences. Some studies considered a more stable and recycled deposition environment (passive margin model), with a significant homogeneity as one of the most important features shared among the complete sequence (Ugidos et al., 1997a, 1997b, 2003a; Valladares et al., 1998, 2000), suggesting that the West Africa Craton was the most likely source for the Late Precambrian rocks (Ugidos et al., 2003b). Geochemical and Sm–Nd data, along with U–Pb detrital zircon populations have allowed other authors to interpret the juvenile contribution to be linked to the waning activity of a long-lived peri-Gondwanan magmatic arc (Cadomian cycle) for the Ediacaran metasedimentary rocks of the CIZ and related peri-Gondwanan domains (Pastor-Galán et al., 2013; Fernández-Suárez et al., 2000, 2014; Gutiérrez-Alonso et al., 2003; Nägler et al., 1995; Orejana et al., 2015; Rodríguez Alonso et al., 2004b; Talavera et al., 2012; Villaseca et al., 2014), proposing a wide range of potential locations for these series along the northern margin of Gondwana during the Late Ediacaran and Early Paleozoic, and therefore different sources for the mantle-derived contributions. In recent years, attempts have been made to explain the evolution of the late stages of the Cadomian orogeny and the accumulation of thick siliciclastic sedimentary successions during the Precambrian–Cambrian transition (Rodríguez Alonso et al., 2004a). Some models propose a passive margin for its deposition (Valladares et al., 2000, 2002), whereas others favor the existence of asymmetric basins formed in a tectonically active setting (Rodríguez Alonso et al., 2004b; Villaseca et al., 2014). The latter models frame such tectonic activity within the evolution from a compressive (Cadomian orogeny) to an extensional regime along the northern margin of Gondwana (Nance et al., 2010).

In the present work, geochemical and Sm–Nd isotopic studies of representative fine-grained sedimentary rocks from the southern Central Iberian Zone have been carried out to discover the sedimentation environment of Late Neoproterozoic and Early Cambrian metasedimentary sequences. Slight differences in the compositions of relatively immobile trace elements as well as significant changes in Nd model ages suggest important differences in the contribution of juvenile or cratonic sources during Late Ediacaran–Early Cambrian times. These differences are used to explore the tectonic setting during this transition and further the knowledge of the geochemistry and sources of the sedimentary series of the peri-Gondwanan realm.

2. Geological setting

Stratigraphic, structural, magmatic and metamorphic criteria were used to define the geotectonic zones within the Iberian Massif section of the Variscan Belt (Arenas et al., 1988; Farias et al., 1987; Julivert et al., 1974; Lotze, 1945; Quesada, 1991) (Fig. 1). One of them is the Central Iberian Zone, an autochthonous section of the Iberian Massif that is bounded to the east and northeast by more external domains of the orogen, the West Asturian–Leonese Zone and the Cantabrian Zone (Fig. 1). The CIZ is thrust by the most internal domain of the orogen, which is represented by allochthonous complexes with high-P metamorphic belts and ophiolites featuring a Variscan suture (Fig. 1; Martínez Catalán et al., 2009). The domain located to the south of the CIZ, the Ossa–Morena Zone, has been recently identified as another allochthonous complex of the Iberian Massif, and is correlated with equivalent complexes of NW Iberia (Díez Fernández and Arenas, 2015).

The CIZ can be divided in two domains: the Ollo de Sapo Domain and the Schist–Greywacke Complex Domain. The Ollo de Sapo Domain, to the North, shows as an essential feature the presence of thick massifs of augen gneisses, abundant Variscan granitoids, and a high-grade regional metamorphism affecting thick Paleozoic series and minor Ediacaran rocks (Díez Montes et al., 2004). The domain to the South, received the name

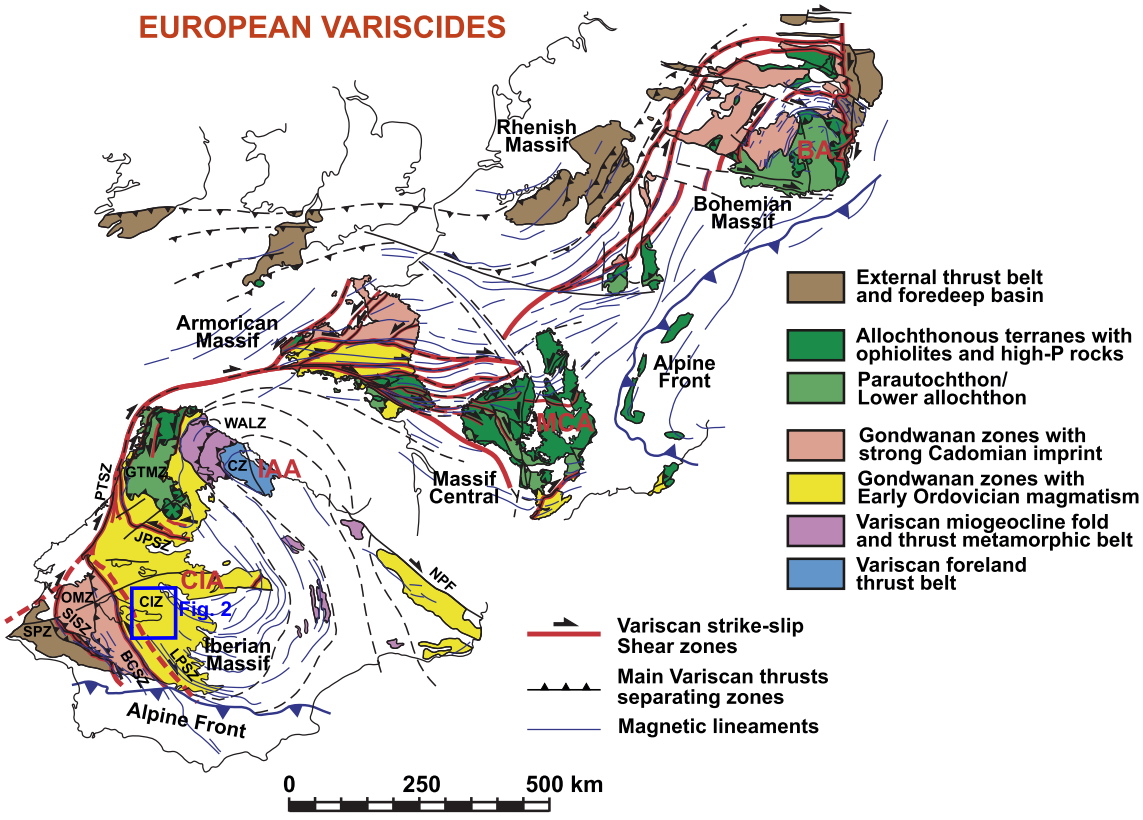

Fig. 1. Terranes and oroclines of the Variscan belt (Martínez Catalán, 2011). Arcs: BA, Bohemian; CIA, Central Iberian; IAA, Ibero-Armorican; MCA, Massif Central. Zones of the Iberian Massif: CIZ, Central Iberian; CZ, Cantabrian; GTMZ, Galicia–Trás-os-Montes; OMZ, Ossa–Morena; SPZ, South Portuguese; WALZ, West Asturian–Leonese. Shear zones and faults: BCSZ, Badajoz–Córdoba; JPSZ, Juzbado–Penalva; LPSZ, Los Pedroches; NPF, North Pyrenean; PTSZ, Porto–Tomar; SISZ, Southern Iberian. Location of the geological map and section presented in Fig. 2 is shown.