Gondwana Research 17 (2010) 338–351

Contents lists available at ScienceDirect

Gondwana Research

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

A peri-Gondwanan arc in NW Iberia I: Isotopic and geochemical constraints on the origin of the arc—A sedimentary approach

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ARTICLE INFO

Article history:
Received 22 April 2009
Received in revised form 17 September 2009
Accepted 23 September 2009
Available online 6 October 2009

Keywords:
Cambrian turbidites
Sediment geochemistry
Nd isotope composition
Provenance
Peri-Gondwanan arc
Allochthonous complexes
NW Iberia

ABSTRACT

The arc-derived upper terrane in the NW Iberia Variscan belt contains a 3000 m thick turbiditic formation at its structural top. Most of the sandstones are feldspathic greywackes with a framework of quartz and weakly altered plagioclase. Rock fragments of vitric and microgranular texture are common in polymictic conglomerates and coarse-grained greywackes, together with slates, cherts and bipyramidal volcanic quartz fragments. Although recrystallization under greenschists facies conditions (chlorite and biotite zones) and the presence of two cleavages hinder detailed textural analysis, the sandstones appear to be typically immature, first-cycle sandstones. The metagreywackes have average major and trace element compositions similar to PAAS (Post Archean Australian Shale), which is considered to reflect the composition of the upper continental crust. Their trace element composition is very consistent and records deposition within a convergent tectonic setting, probably in an intra-arc basin located in a volcanic arc built on thinned continental margin. Detrital zircon populations suggest a Middle Cambrian maximum depositional age (530–500 Ma) and a Gondwanan provenance located at the periphery of the West African Craton. Nd isotope data suggest mixing Ediacaran and Paleoproterozoic sources for the provenance of the greywackes, with T_{DM} ranging between 720 and 1215 Ma with an average of 995 Ma ($n=20$)—an age range unrepresented in the detrital zircon population. The Nd model ages are similar to those exhibited by West Avalonia, Florida or the Carolina terrane, but younger than those of Cambrian and Ordovician sandstones and shales from the autochthonous realm. These data suggest a westernmost location along the Gondwanan margin for the upper terrane of NW Iberia relative to other terranes located in the footwall of the Variscan suture, consistent with several previously proposed paleogeographic models for the NW Iberia terranes.

1. Introduction

The European Variscan Belt and its continuation through the Appalachian Orogen is a major orogenic belt developed during the final stages of the assembly of Pangea as a result of the closure of the Rheic Ocean (Casini and Oggiano, 2008; Nance et al., 2010-this issue; Keppie et al., 2010-this issue; Melleton et al., 2010) and the collision between Gondwana and Laurussia (Matte, 1991; Martínez Catalán et al., 2007), which was probably oblique (Arenas et al., 2009). In Europe, the most internal part of this belt includes a succession of allochthonous complexes that define the main suture zone and are considered to be remant klippen of a large nappe pile (Fig. 1). The allochthonous complexes in the NW Iberian Massif include three main terranes designated, from bottom to top, the basal units, ophiolitic units and upper units (Fig. 2). The basal units are considered to be the most external margin of Gondwana subducted beneath Laurussia at the onset of Variscan deformation (c. 370 Ma; Arenas et al., 1995; Martínez Catalán et al., 1996; Rodríguez et al., 2003; Abati et al., 2010), whereas the upper units are interpreted to be an arc-derived terrane. This arc also has a peri-Gondwanan provenance (Fernández-Suárez et al., 2003), but left the main continent during the Middle Cambrian–Early Ordovician and drifted north contemporaneously with the opening of the Rheic Ocean, which is represented within the stack of allochthonous units by different types of ophiolites (Díaz García et al., 1999; Pin et al., 2002; Arenas et al., 2007; Sánchez Martínez et al., 2007a,b). This rifted arc was finally accreted to the southern margin of Laurussia during the Lower or Middle Devonian (Gómez Barreiro et al., 2007).

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doi:10.1016/j.gr.2009.09.007

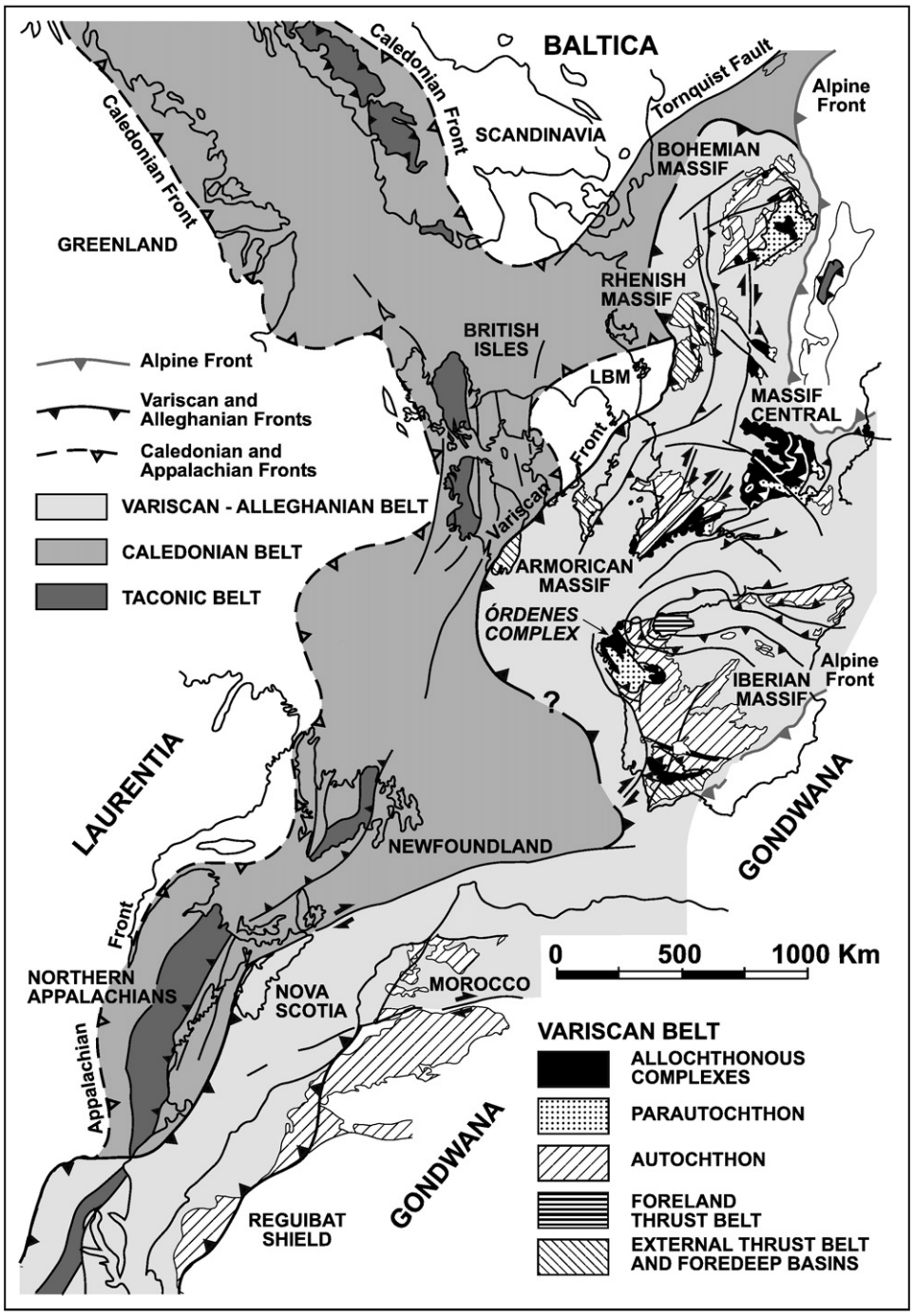

Fig. 1. Sketch showing the distribution of the Paleozoic orogens in a reconstruction of the Baltica–Laurentia–Gondwana junction developed during the assembly of Pangea. The distribution of the most important domains described in the Variscan Belt is also shown, together with the position of the Órdenes Complex in NW Iberia. LBM: London-Brabant Massif. From Martínez Catalán et al. (2002).

Different articles have described the structure and general metamorphic evolution of the arc-derived upper units of the allochthonous complexes of NW Iberia (see Martínez Catalán et al., 2002 and references therein), and data also exist on the geochronology of the tectonothermal events and main magmatic pulses. However, most previous work on the tectonothermal evolution of these units has focussed on events related to the accretion of the arc to Laurussia, and its subsequent Variscan history. Details of the arc's tectonothermal evolution during its development at the periphery of Gondwana are less well known. In addition, the location of the arc within peri-Gondwana and whether it was built on the Gondwanan continental margin or was generated above an intra-oceanic subduction zone at some distance from the margin, remain unknown. To help resolve these issues, we present two consecutive papers on aspects related to the initial development of this magmatic arc. The first paper describes the geochemical features, tectonic setting and provenance of the thick low-grade greywacke series that occupies the uppermost structural position in the upper units of the Órdenes Complex (Figs. 1 and 2) in order to constrain the tectonic setting of the magmatic arc, its internal constitution and its location within peri-Gondwana. The second describes the internal structure of the metagreywacke series and presents new U–Pb age data for a diabasic dyke swarm that intrudes the metasediments (Díaz García et al., 2010-this issue). The new age data constrains the origin of the main fabric at the upper structural levels in the Órdenes Complex and its relationship to magmatic arc dynamics.