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U–Pb ages of detrital zircons from the Basal allochthonous units of NW Iberia: Provenance and paleoposition on the northern margin of Gondwana during the Neoproterozoic and Paleozoic

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ABSTRACT

LA-ICP-MS U–Pb ages of detrital zircons from eight siliciclastic samples from the Basal units of the Variscan allochthonous complexes of NW Iberia are used to establish the maximum depositional age and provenance of two tectonically-stacked metasedimentary sequences deposited on the outermost margin of Gondwana, and subsequently involved in the Rheic Ocean suture. The maximum depositional ages for the two sequences is latest Neoproterozoic and latest Cambrian, respectively. The age spectra are also used to discuss the paleoposition of the NW Iberian basement on the continental margin of Gondwana prior to the opening of the Rheic Ocean, which is tentatively placed in northern Africa, between the West African and Saharan cratons. Based on similarities and differences with age data from the NW Iberian autochthon and other allochthonous terranes involved in the Rheic suture, the relative proportions of Mesoproterozoic zircons in both assemblages are proposed as markers of proximity to the eastern part of the West African craton during late Neoproterozoic and late Cambrian. The geodynamic processes that took place along this part of Gondwana during the late Neoproterozoic, late Cambrian and Early Ordovician are discussed in the light of the LA-ICP-MS results, as well as the sedimentological record, magmatic evolution and plate tectonic setting of NW Iberia. These processes are linked to late Neoproterozoic and Cambro-Ordovician subduction events beneath the northern Gondwanan margin.

1. Geological setting

The allochthonous complexes of NW Iberia are a stack of nappes thrust over the sequences of the Iberian autochthon (Fig. 1a), which formed part of the northern margin of Gondwana for the entire Paleozoic (Martínez Catalán et al., 2007, 2009).

Three groups of allochthonous units have been distinguished (Fig. 1b and c). The Upper units, on top of the nappe pile, are pieces of a Cambro-Ordovician ensialic island arc (Abati et al., 1999, 2003; Andonaegui et al., 2002; Santos et al., 2002) inferred to have been detached from northern Gondwana by the roll-back of the subducting slab of the Iapetus–Tornquist ocean, to leave a new oceanic realm, the Rheic Ocean, in its wake (Stampfli and Borel, 2002; Stampfli et al., 2002; Winchester et al., 2002; von Raumer et al., 2003; Abati et al., 2010).

Relicts of oceanic floor form the middle allochthonous units, known as the Ophiolitic units, represent the suture of the Rheic Ocean (Díaz García et al., 1999; Pin et al., 2002, 2006; Arenas et al., 2007; Sánchez Martínez et al., 2007) and possibly remnants of older oceanic domains (Sánchez Martínez et al., 2006; Sánchez Martínez, 2009).

The Basal units, at the base of the nappe stack, represent distal parts of the Gondwana continental margin. They preserve calc-alkaline igneous rocks roughly coeval with the Cambro-Ordovician suite of the Upper units (Abati et al., 2010), and experienced extension and rift-related magmatism during the Ordovician (Floor, 1966; Ribeiro and Floor, 1987; Pin et al., 1992), while the Rheic oceanic lithosphere was being created. Subsequently, the Basal units were subducted beneath Laurussia at the onset of Variscan collision (Arenas et al., 1995, 1997; Santos Zalduegui et al., 1995; Rodríguez et al., 2003; Abati et al., 2010), and exhumed by crustal-scale thrusting accompanied by recumbent folding and tectonic denudation during the Variscan Orogeny (Martínez Catalán et al., 1996, 1997; Díez Fernández and Martínez Catalán, 2009).

An imbricate thrust sheet, composed of siliciclastic sedimentary and volcanic rocks known as the Parautochthon, Lower allochthon or Schistose domain, separates the allochthonous complexes from the autochthon. The latter consists of a thick metasedimentary sequence which, as with the Lower allochthon and the Basal units, was deposited along the northern margin of Gondwana. The autochthonous sedimentary sequences of NW Iberia record the late Neoproterozoic and early

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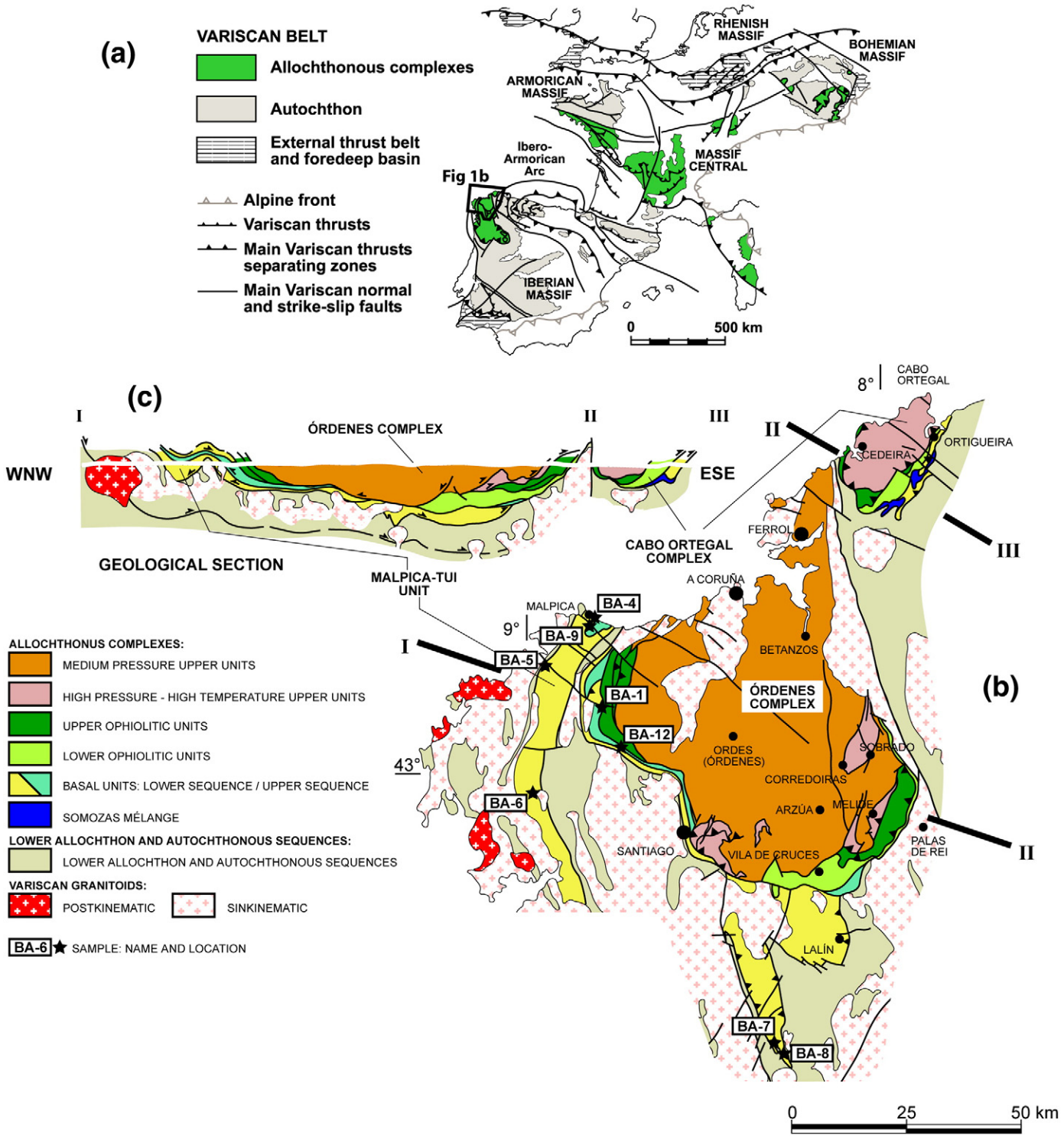

Fig. 1. (a) Location of the study area in the Variscan belt of Europe. (b) Map showing the allochthonous complexes of Órdenes, Cabo Ortegal and northern half of Malpica-Tui in Galicia, NW Spain, and the location of samples analyzed. (c) Representative cross section showing the general structure. Note the nappe stacking and the position of the Lower and Upper sequences. Top-to-the-ESE kinematics often represents thrusting, whereas top-to-the-WNW movement is related to extensional collapse and reactivation of previous structures.

Paleozoic evolution of the northern Gondwana margin, including the Avalonian–Cadomian active margin in the Neoproterozoic (Rodríguez Alonso et al., 2004), the development of a passive margin during the Cambrian, the Cambro-Ordovician opening of the Rheic Ocean, and the return to passive-margin conditions until the onset of the Variscan collision in Late Devonian times (Martínez Catalán et al., 2007, 2009; von Raumer and Stampfli, 2008).

2. The stratigraphic succession of the Basal units

The Basal allochthonous units comprise two tectonically juxtaposed metasedimentary sequences (Fig. 1c), the Upper sequence representing a paleogeographic domain distinct from that of the Lower sequence. Both sequences were involved in the initial subduction that preceded Variscan collision, but the Lower sequence developed eclogite facies