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Geochemistry and metamorphism of the Mouriscas Complex, Ossa-Morena/Central Iberian zone boundary, Iberian Massif, Central Portugal: Implications for the Cadomian and Variscan orogenies

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ABSTRACT

The Mouriscas Complex is a deformed and metamorphosed predominantly mafic igneous complex of Ediacaran and Ordovician age and crops out at the Ossa-Morena/Central Iberian zone boundary in the Iberian Massif, Central Portugal. It comprises amphibolite with Neoproterozoic protoliths (ca. 544 Ma), protomylonitic felsic dykes derived from younger trondhjemitic protoliths (ca. 483 Ma) and garnet amphibolite derived of even younger dioritic protoliths (ca. 477 Ma). The protoliths of the Neoproterozoic amphibolites are calc-alkaline magmas of basic to intermediate compositions with intraplate and active continental margin affinities and are considered to represent the final phase of the Cadomian arc magmatism. They are interpreted to have originated as coarse-grained intrusions, likely gabbro or diorite and generated from the partial melting of meta-igneous lower crust and mantle. Their emplacement occurred near the Cadomian metamorphic event dated at ca. 540 Ma (P = 7–8 kbar and T = 640–660 °C) which is interpreted to represent a continental collision. During the Late Cambrian-Early Ordovician an extensional episode occurred in the central-southern Iberian Massif and was also observed in other areas of the Variscan Orogen. It led to mantle upwelling and to the development of an aborted intracratonic rift located at the Ossa-Morena/Central Iberian zone boundary and to the opening of the Rheic Ocean to the south of the area studied in present coordinates (i.e., between the Ossa-Morena and South Portuguese Zones). This event has been dated at ca. 477 Ma and was responsible for the melting of deep ancient mafic crust and mantle with formation of bimodal magmatism in an intra-plate setting, as indicated by the protoliths of the protomylonitic felsic dykes with trondhjemitic composition and of the garnet amphibolite. Subsequent Variscan metamorphism took place under amphibolite facies conditions (P = 4–5.5 kbar; T = 600–625 °C) at lower P-T conditions than the Cadomian metamorphic event. It was followed by greenschist retrogression as suggested by the appearance of actinolite rims and formation of chlorite and epidote.

1. Introduction

The Cadomian Orogen formed in an active margin setting at the periphery of Gondwana, in the period ca. 750–540 Ma (e.g. Linnemann et al., 2007 and references therein), which was followed by the Early Palaeozoic rifting from ca. 530 to 485 Ma and opening of the Rheic Ocean (e.g. Nance et al., 2010; Sánchez-García et al., 2008 and references therein). The later northward movement of Gondwana and its marginal terranes resulted in closure of the Rheic Ocean during the Devonian-Carboniferous leading to the Variscan orogeny (e.g. Strachan et al., 2014 and references therein). The Rheic Ocean separated the great paleocontinents of Gondwana and Laurussia as the principal interior ocean of the Paleozoic, and it is the evolution of this ocean that dominates the geology of southern Europe, eastern North America and northern Africa (Nance et al., 2012 and references therein).

Fragments of the Cadomian Orogen are found in the Armorican, Bohemian and Iberian Massifs (e.g. Bandrés et al., 2004; Inglis et al., 2005; Linnemann et al., 2008; Nance et al., 2008 and references therein). In the Iberian Massif a well-preserved Cadomian basement crops out at the Olivenza-Monesterio Antiform (e.g. Ordóñez-Casado, 1998 and references therein) and at the Ossa-Morena/Central Iberian zone boundary, which was affected by tectonometamorphic events of the Cadomian and Variscan orogenies (e.g. Dallmeyer and Quesada, 1992; Eguíluz et al., 2000; Henriques et al., 2015; Ordóñez-Casado, 1998; Ribeiro et al., 2009). This boundary, where the Mouriscas Complex

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crops out, is a key area for the characterization of these events, which are important for the elaboration of geodynamic models of northern Gondwana and its peripheral terranes.

In this work we present geology, detailed petrography, mineral chemistry and whole-rock geochemical data (major and trace elements and oxygen isotopes) on the last magmatic episode of the Cadomian orogeny. We also use the ID-TIMS ages of zircon and monazite from these rocks (Henriques et al., 2015). These results constrain the nature of protoliths and their magmatic sources, which are important to understand the petrogenetic processes that occurred prior to the collisional event in the northern margin of Gondwana. We address the origin of Early Ordovician bimodal magmatism in the context of crustal extension of the Variscan orogen, which is a contribution to the understanding of processes of magma generation in zones of active extension. Finally we use petrography, mineral chemistry and thermodynamic modelling to characterize the Variscan metamorphic event.

2. Geological setting

The Mouriscas Complex is located within the Tomar-Badajoz-Córdoba Shear Zone, at the Ossa-Morena/Central Iberian zone boundary, Iberian Massif, near Abrantes area, Central Portugal (Fig. 1a). The Iberian Massif represents the westernmost segment of the European Variscides (e.g. Burg and Matte, 1978; Dallmeyer and Martínez García, 1990). It was first subdivided into different tectonostratigraphic units by Lotze (1945) and later modified by several other authors (e.g. Farias et al., 1987; Julivert et al., 1972; Ribeiro, 2013).

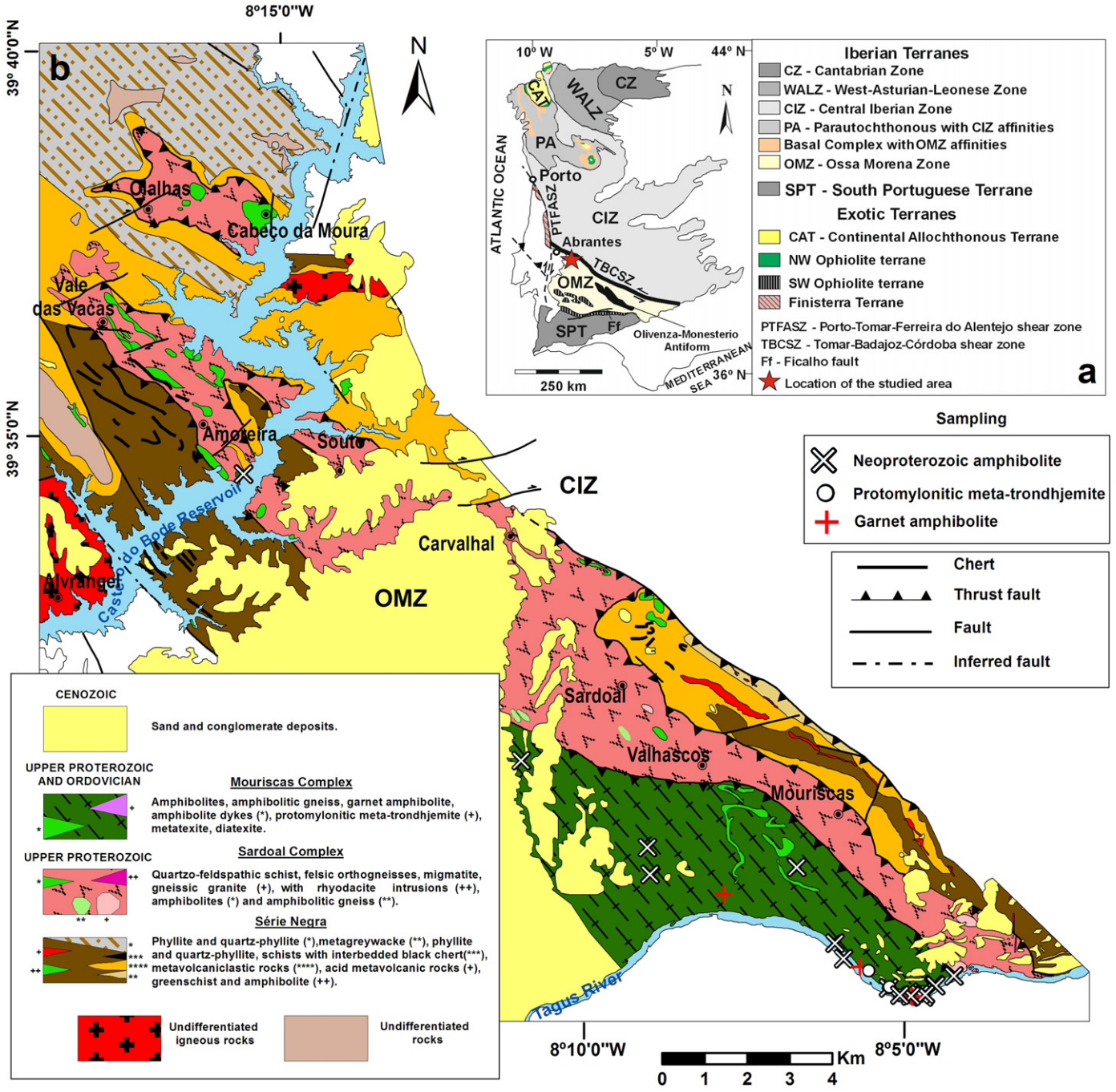

Fig. 1. (a) Location of the studied area in the Iberian Massif. Subdivisions of the Iberian Massif after Ribeiro (2013). (b) Location of representative samples (Table 1) in the geological map adapted from Zbyszewski et al. (1983), Conde (1984) and Romão and Esperancinha (2000). Thrust faults after Ribeiro et al. (2013). Projection system: ETRS_1989_Portugal_TM06.