Available online at www.sciencedirect.com

SCIENCE DIRECT®

Palaeogeography, Palaeoclimatology, Palaeoecology 229 (2005) 83–103

PALAEO

www.elsevier.com/locate/palaeo

Magmatism in the intracratonic Central Iberian basins during the Permian: Palaeoenvironmental consequences

Marceliano Lago*, Andrés Gil, Enrique Arranz, Carlos Galé, Andrés Pocoví

Departamento de Ciencias de la Tierra, Universidad de Zaragoza, 50.009 Zaragoza, Spain

Received 22 January 2004; received in revised form 29 September 2004; accepted 24 June 2005

Abstract

Recent studies have confirmed the important role played by magmatism during the Late Carboniferous–Permian transition. In this report, we describe the characteristics of this magmatism in the Central Iberian realm (Iberian Ranges and eastern Spanish Central System) and discuss its palaeoenvironmental impact. In the studied area, the late-Variscan transtensional to extensional tectonic regime favoured the emplacement of a calc-alkaline magmatism during the Late Stephanian–Permian. This magmatism is expressed both as pyroclastic rocks filling small half-graben basins and hypabyssal intrusions (sills and dykes). Pyroxenic- and amphibolic-andesites are the main rock compositions, while basalt, dacite and rhyolite are less represented. The available K/Ar isotopic data suggests a Lower Permian age for this magmatism, also supported by its complete macro- and microflora content and by features related to its emplacement (hypabyssal intrusions crosscut Stephanian rocks and are in turn overlain by late Permian–Triassic sediments). Frequent xenoliths of middle and lower crustal levels indicate considerable magma–crust interaction. This interaction may have led to substantial crustal assimilation during the first emplacement stages in conditions of a low extension rate. Crustal contamination barely affected the final magmatic products emplaced under conditions of greater extension. The palaeoecological effects of explosive manifestations of this volcanism are expressed in the varied macroflora record in volcaniclastic basins. The number and volume of hypabyssal intrusions suggest that the original geological record of explosive activity in these basins was much greater and was reduced by subsequent erosion processes.

Keywords: Calc-alkaline; Lower Permian; Upper Carboniferous; Volcaniclastics; Central Iberia; Palaeoenvironment

1. Introduction

This study focuses on the calc-alkaline magmatism active during the Late Carboniferous–Early Permian in the Iberian Ranges and eastern Central System. Igneous activity in these areas shows widespread development, expressed in two types of outcrop: (a) volcaniclastic deposits in several basins and (b) a large number (over a thousand outcrops mapped) of intrusions (sills and dykes; Lago et al., 2004a). Based on this information, we assess the effects of this magmatism and discuss–in more detail–the palaeoenviron-

* Corresponding author. Tel.: +34 976761069; fax: +34 976761106.

E-mail address: mlago@posta.unizar.es (M. Lago).

0031-0182/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.palaeo.2005.06.032

mental impact of its explosive manifestations and its relationships with other Late Carboniferous–Permian magmatic events in the Iberian realm, as is the coeval volcanism in the Pyrenean Chain (Lago et al., 2004b).

From a structural point of view, the studied outcrops are part of two different Alpine ranges: the Spanish Central System and the Iberian Ranges. The Palaeozoic rocks in these two realms were deformed during the Variscan orogeny and belong to the Iberian Massif: the Spanish Central System (SCS) is part of the Central Iberian Zone (Julivert et al., 1972) whereas the outcrops of Palaeozoic rocks in the Iberian Ranges belong to the West Asturian Leonese and Cantabrian Zones of the Iberian Massif (Julivert et al., 1972; Gozalo and Liñán, 1988). The Palaeozoic rocks of the eastern SCS and the Iberian Ranges were the substrate for the development of Permian and Mesozoic sedimentary basins with a variably complete sedimentary record that reflects their different tectonic and sedimentary evolution.

1.1. Late-Variscan evolution of central Iberia

During Variscan compression, the thickness of the crust in the Central Iberian realm increased to around 50–60 km, triggering widespread regional metamorphism and anatexis, which resulted in the generalised intrusion of granitoids. This process caused substantial crust instability and extensional collapse (Doblas et al., 1994) during the late Variscan (Stephanian–Lower Permian). A network of strike-slip faults marked the separation of the Iberian Plate to the N, and in its interior, two main families of shear faults (NW–SE and NE–SW) divided the old Variscan edifice in several crustal blocks (Arthaud and Matte, 1975; Capote, 1978, 1983). During the Stephanian–Permian transition, the transtensional tectonic regime controlled the development of relatively isolated, narrow intermontane half-grabens limited by uplifted blocks. The faults that controlled the formation and evolution of these half-grabens were probably related, in depth, to a significant listric fault of Iberian direction, dipping towards the NE (Arche and López-Gómez, 1996). The outcrops of these basins are scattered along the eastern SCS (Atienza; Fig. 1b) and Iberian Ranges (e.g., Pálmaces, Ojos Negros, Orea, Bronchales, Eslida, Fombuena; Fig. 1b). This tectonic regime also favoured the ascent of the calc-alkaline magmatism examined here. In the Late Permian, the incipient basins in the area of the Iberian Ranges evolved into well-developed half-grabens which, at the beginning of the Triassic, led to the formation of an extensive symmetrical basin, the Iberian Basin (Sopeña et al., 1988; López-Gómez et al., 2002), whereas the eastern SCS remained as an almost stable block.

1.2. Alpine evolution of the Iberian basin and eastern SCS

The movement of NW–SE and NE–SW trending faults inherited from tardi-Variscan deformation controlled the evolution of the Iberian Basin during the Mesozoic. Sequential stratigraphic studies and the analysis of subsidence in the Mesozoic succession have revealed several rapid subsidence episodes alternating with slower episodes, well correlated on the Iberian Basin scale (Van Wees et al., 1998). This complete set of subsidence episodes has been grouped into two large cycles (Alvaro, 1987; Sánchez-Moya et al., 1992; Salas and Casas, 1993; Salas et al., 2001; Sopeña and Sánchez-Moya, 2004):

- Late Permian–Norian (the post-rift stage covered the Rhaetian–Oxfordian interval). The Upper Triassic and Middle Jurassic succession includes outcrops of alkaline hypabyssal and volcaniclastic rocks.
- Late Jurassic–Middle Albian rift cycle (post-rift during the Late Albian to Maastrichtian).

As a consequence of these rifting events, the Iberian Basin was filled by a thick Mesozoic sedimentary sequence. The Alpine compression produced the positive tectonic inversion of this basin during the Late Mesozoic–Tertiary. Mesozoic sediments, dominant in outcropping surface, appear as large NW–SE verging folded zones, or as less deformed platforms, separated by intermontane basins infilled with Tertiary continental deposits. Five large structural units have been defined according to the interior basins, deformation style and the dominant deposits (Fig. 1a, b): (a) the La Demanda-Cameros Massif to the NW, composed of a Palaeozoic core, covered by Upper Jurassic–Lower Cretaceous materials overthrusting the Ebro Basin; (b) the Aragonese–or Eastern–Branch, that comprises the Palaeozoic massifs of Ateca-Daroca and Cala-