First record of Tethyan Ladinian involutinid foraminifera-rich beds in the Betic Internal Zone (SE Spain)

Primer registro de niveles ricos en foraminíferos involutínidos tethysianos del Ladiniense en la Zona Interna Bética (SE de España)

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RESUMEN

Generalmente se acepta la idea de que los dominios que actualmente constituyen las Zonas Interna y Externa de la Cordillera Bética estaban muy próximos, si no adyacentes, durante el Triásico. Sin embargo, los modelos geodinámicos propuestos en los últimos años indican que ambos dominios pertenecían, durante el Jurásico y el Cretácico, a dos placas tectónicas diferentes, que llegaron a distar varios cientos de kilómetros. Si se considera además que entre ambas placas tuvo lugar una colisión oblicua, podría cuestionarse la proximidad original entre dichos dominios. El hallazgo de niveles de calizas muy ricos en foraminíferos bentónicos (involutínidos) en el Triásico de la Sierra de Gádor (Complejo Alpujárride, Zona Interna), análogos a los reconocidos por autores previos en la Zona Externa Bética, donde han sido relacionados con un bioevento de carácter regional, constituye una evidencia a favor de que los dominios béticos internos y externos pertenecían a una misma región paleogeográfica durante el Triásico.

Palabras clave: *Involutinidae, Triásico alpino, Triásico germánico, Complejo Alpujárride.*

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Introduction

The Betic Cordillera is classically divided into three major structural domains: the External and Internal Zones and the Campo de Gibraltar Flysch Complex. The External Zone consists of Alpine tectonic units deriving from the deformation of the domain known as Southern Iberian Palaeomargin. The Triassic successions of this domain were deposited on rifted continental crust to the south of the Iberian plate, and are mainly characterized by terrigenous-clastic and evaporite-rich, continental and coastal Germano-Andalusian facies with interbedded shallow marine carbonates, these later tens to hundred of metres thick. The Betic Internal Zone is formed by three stacked Alpine tectonic complexes (Malaguide, Alpujarride, and Nevado-Filabride complexes, from top to bottom), plus a group of imbricated Frontal Units, deriving from the deformation of a Mesomediterranean realm, different from Iberia and North Africa, and made up of Palaeozoic (and older?) and Meso-Cenozoic rocks. The Triassic of the Internal Zone comprises continental clastics and very thick (up to more than 1 km) shallow marine carbonates with Alpine facies originally deposited on the continental margin of the Mesomediterranean Microcontinent (Martín-Algarra and Vera, 2004). According to recent models, after the Pangea continental rifting and during the Jurassic and Cretaceous drifting the Iberian and Mesomediterranean blocks evolved into two different tectonic plates: the Iberian plate and the Mesomediterranean microplate. At the end of the Mesozoic, hundreds or even thousands of kilometres, occupied by the Western Tethys Ocean and its surrounding palaeomargins, separated the above-mentioned plates. This palaeotectonic configuration changed from the Late Cretaceous onwards, because of the convergence between the African and European plates and subduction of the Tethyan lithosphere. Such a convergence was responsible for a westward lateral extrusion of the already deformed Mesomediterranean microplate, and for the origin of the Betic Cordillera as a consequence of its oblique collision against Iberia (Martín-Algarra and Vera, 2004).

The aim of the present research is to point out for the presence of beds with abundant Ladinian benthic foraminifers of Tethyan origin, here studied in detail for the first time, in the Alpujarride Complex. These beds strongly resemble analogous layers found in the External Domain, and can be considered an significant Ladinian marker, and its finding is important for the palaeogeographic reconstructions of the Pangea scenario.

The foraminifera-rich beds

The foraminifera-rich beds here studied are found in the lower part of the Alpujarride meta-carbonate formation belonging to the Gador-Turón unit (Sierra de Gádor, NW

Almería, SE Spain). Few stratigraphic and facies data exist yet about this formation of the Sierra de Gádor, but previous authors reported some microfossil-rich beds (Jacquin, 1965, 1971; Sierra López *et al.*, 1968; Perconig, 1968, 1977; Somma *et al.*, 2009). Martín-Rojas *et al.* (2009) divided this meta-carbonate formation into six informal members that are, from bottom to top (Fig. 1): (1) dolomitic-calcareous-marly member, (2) dolomitic member, (3) fossiliferous calcareous-marly member, (4) cherty calcareous member, (5) mineralized calcareous-dolomitic member and (6) marly-calcareous member.

The foraminifera-rich beds appear at the top of member 1 (Fig. 1). The lower-middle part of this member is made up of massive, recrystallized, grey dolostones (Fig. 1). In detail, the upper part of the member 1 consists of six cycles made, from bottom to top, of: a) yellowish marls (1-5 m thick), grading upwards to b) limestones bearing molluscs (2-7 m thick); and c) brown dolostones (1-2 m thick). These are followed by other two similar decametre-thick cycles but containing the foraminifera-rich limestones here studied instead of the limestones with molluscs (Fig. 2a). The foraminifera-rich limestones, present in the two above-mentioned cycles, show a total thickness ranging from 2 to 7 m. These limestones are organized in sets of parallel laminated, decimetre thick beds. Textures consist of packstones-wackestones; the main skeletal grains are represented by reworked benthic foraminifera up to 1 mm in size (Fig. 2b-c). They correspond to peri-reefal to basinal, typically Tethyan Involutinidae biofacies (Rettori, 1995; Márquez, 2005). The association (Fig. 2d) is represented by abundant specimens of *Lamelliconus* gr. *biconvexus–ventroplanus* and *Lamelliconus cordevolicus* (Oberhauser). The chronostratigraphic range of these involutinids extends from the Ladinian to the Carnian. Nevertheless, both abundance and size of these taxa are consistent with a Ladinian age for these beds.

The beds with reworked rests of involutinids are also rich in lagenids and sponge spicules. The reworked foraminifers were redeposited in an area between middle and outer ramp environments (Martin-Rojas *et al.*, in this volume). After having proliferated in peri-reefal or proximal ramp, these involutinids were reworked and transported,

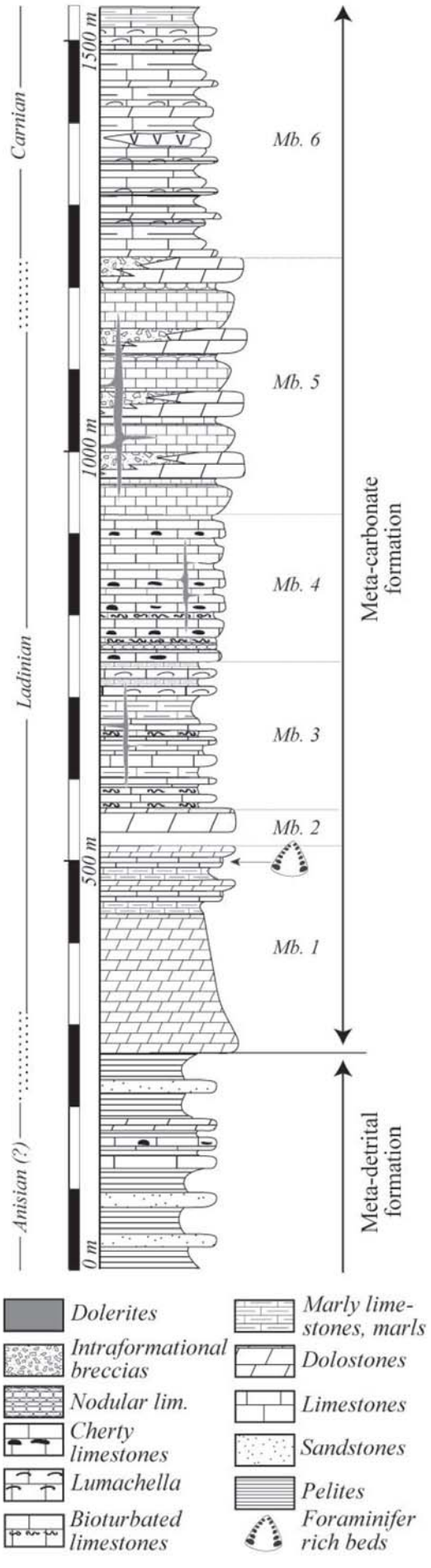

Fig. 1.- Synthetic stratigraphic column of the Gádor-Turón unit.

Fig. 1.- Columna estratigráfica sintética de la unidad de Gádor-Turón.

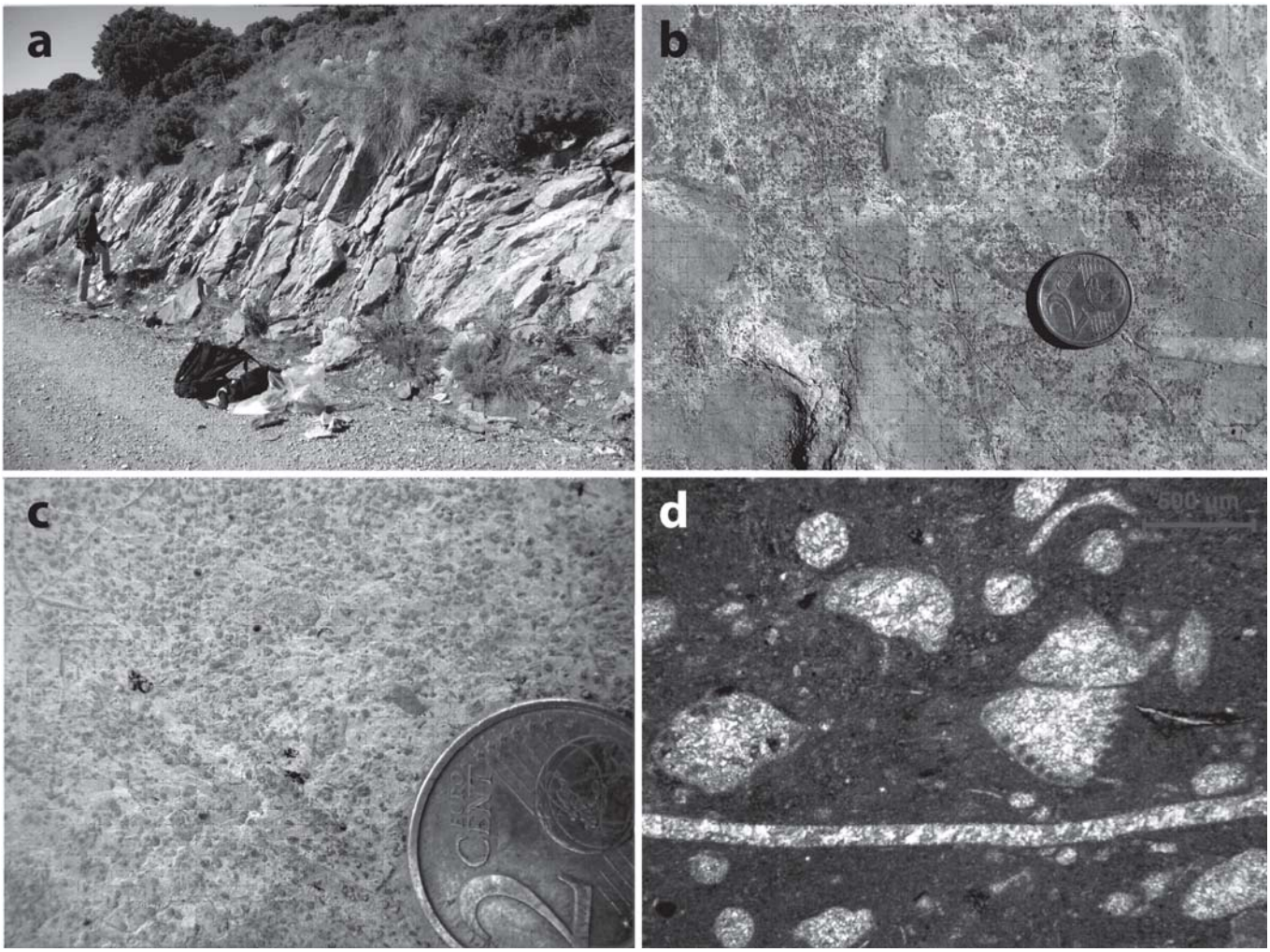

Fig. 2.- a) Outcrop view of foraminifer-rich beds. b-c) Stratal surface of the foraminifera-rich beds. d) Microphotograph of the foraminifers assemblage.

Fig. 2.- a) Afloramiento de los niveles ricos en foraminíferos. b-c) Detalle de la superficie de estratificación de los niveles ricos en foraminíferos. d) Vista al microscopio de la asociación de foraminíferos.

presumably as a consequence of storm events, towards deeper areas between the fair-weather wave base and the storm-weather wave base, as the transition zone of the ramp to the basin. The occurrence of lower flow regime parallel lamination in these beds strengthens this hypothesis.

Discussion and conclusions

Tethyan realm taxa (foraminifers, bivalves, brachiopods, among many others) are widely developed in the Alpine Triassic Domains (southern Alps, Carpathians, Turkey). By contrast, in the Germanic Triassic Domains, beds rich in Tethyan fossils are scarce and they have been found only locally in Germany, France, and Spain (Pyrenees, Iberian and Catalan Ranges, Betic External Zone). Particularly, Ladinian foraminifera-rich beds, analogous to those described here for the first time in the Betic Internal Zone, have been found in the *Muschelkalk* of the Betic External Zone (López-Garrido *et al*., 1997; Pérez-López *et al*., 2003, 2005). These *Muschelkalk* beds are also characterised by unusually high concentrations of large-sized benthic foraminifers (*Lamelliconus* gr. *biconvexus–ventroplanus*, *Lamelliconus cordevolicus* Oberhauser, *Triadodiscus eomesozoicus* Oberhauser; *Trochammina jaunensis* Bronnimann and Page, *Endotriadella* cf. *wirzi* Koehn–Zaninetti) but have a thickness of only around 10 cm. These foraminiferal marker beds have been interpreted as event beds, and they postulate that they were deposited during a main stage of Ladinian sea-level rise (Pérez-López *et al*., 2005). Such a sea-level rise covered extensive coastal areas, allowing involutinid foraminifers to migrate and occupy new habitats. These newcomers gave rise to communities that occasionally became very numerous and supplied skeletal grains to tempestites responsible for the foraminifera-rich beds. According to Pérez-López *et al*. (2005) such marker beds reflect an isochronous bioevent that has been now identified in the Alpujarride Complex, thus reinforcing its regional and ecostratigraphic significance.

The Internal and External Betic Domains, with Alpine and Germanic-type Triassic facies, respectively, have usually been considered to be palaeogeographically connected during the Triassic, despite they would belong to different tectonic plates during the post-Triassic plate dispersal. The strong similarity between the foraminifera-rich beds from the Betic Internal Zone here

reported and those from the Betic External Zone interpreted by previous authors as related to Ladinian regional bioevents, supports that both domains would have been very close, or even adjacent, at least during the Middle Triassic.

In conclusion, the Ladinian foraminifera-rich beds represent an important marker to reconstruct the Ladinian palaeogeography of the Betic Triassic basins.

Acknowledgments

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References

López-Garrido, A.C., Pérez-López, A. y Sanz de Galdeano, C. (1997). *Comptes Rendus Accademie Science Paris*, 324, 647-654.

Martín-Rojas, I., Somma, R., Zamparelli, V., Estévez, A., Delgado, F. y Perrone, V. (2009). *Journal of the Geological Society of London*, 166, 1-12.

Pérez-López, A., López-Garrido, A.C., Marquez-Aliaga, A., Sanz De Galdeano, C. y García-Tortosa, F. (2003). *Facies*, 48, 1-8.

Pérez-López, A., Márquez, L. y Pérez-Valera, F. (2005). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 224, 217-231.

Rettori, R. (1995). *Publications du Departement de Geologie et Paleontologie*, Univ. de Genève, 18, 1-150.

Jacquin, J.P. (1965). *Comptes Rendus sommaire de la Societé Géologique France*, 265-266.

Jacquin, J.P. (1970). Tesis Doctoral, Univ. Nantes, 501p.

Márquez, L. (2005). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 229, 137-157.

Martín-Algarra, A. y Vera, J.A. (2004). En: *Geología de España*, Cap. 4 (J.A.Vera, Ed.), SGE-IGME, Madrid, 352-354.

Perconig, E. (1968). *International Sedimentary Petrographycal Series*, vol. X, E.J. Brill, Leiden.

Perconig, E. (1977). *Cuadernos de Geología Ibérica*, 4, 295-306.

Sierra López, J., Ortiz Ramos, A. y Burkhalter Anel, J. (1967). *Not. y Com.* IGME, 97-98, 289-308.

Somma, R., Martin-Rojas, I., Delgado, F., Estévez, A., Iannace, A., Perrone, V. y Zamparelli V. (2009). *Geogaceta*, 47, 1-4.