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New palynological and isotopic data for the Triassic of the western Cantabrian Mountains (Spain)

Nuevos datos palinológicos e isotópicos del Triásico de la Cordillera Cantábrica occidental (España)

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Abstract

Triassic carbonate rocks of the western Cantabrian Mountains, northern Spain, have long been attributed to the Muschelkalk facies, and as such have been correlated with other Middle Triassic carbonate units of the Iberian Peninsula. Data on palynological assemblages here presented, point to a Ladinian-lower Carnian age of the upper part of the Buntsandstein facies in this area. In addition, the 87Sr/86Sr ratio of the limestones formerly attributed to the Muschelkalk facies indicates a Norian or Norian-Rhaetian boundary age. These findings also imply that the position of the marine coast during the Middle Triassic Tethys transgression should be moved to a more easterly position, in the Basque Country.

Keywords: Palinology, Sr isotopes, Ladinian, Carnian, Triassic, Cantabrian Mountain, Spain

Resumen

Las rocas carbonatadas triásicas que afloran en la zona occidental de la Cordillera Cantábrica en el norte de España, han sido tradicionalmente atribuidas al Muschelkalk por correlación con las unidades carbonatadas del Triásico Medio de otras áreas de la Península Ibérica. Las asociaciones palinológicas encontradas en la parte superior de las facies Buntsandstein que afloran en esta área, indican una edad Ladiniense-Carniense inferior. La relación 87Sr/86Sr de los niveles de calizas atribuidos anteriormente al Muschelkalk, son propios de los carbonatos de edad Noriense o Noriense-Rhetiense. Estos datos implican, además, que la posición de la línea de máximo avance del mar del Tethys hacia occidente durante el Triásico Medio se situó en una posición más oriental y dentro del País Vasco.

Palabras clave: Palinología, isótopos de Sr, Ladiniense, Carniense, Triásico, Cordillera Cantábrica, España.

1. Introduction

As in other areas of Western Europe, three incursions of the Tethys Ocean are recognized in Spain between the Middle and Late Triassic. The location of the western edge of the Triassic Tethys realm for each one is still to be established, at least for the first two of such lower and middle incursions. One of the most poorly understood areas is the western part of the Basque-Cantabrian Basin (Fig. 1), where traditionally the western margin for the Middle Tethys transgression has been thought to lie (Robles and Pujalte, 2004; López-Gómez *et al*., 2002). In this area a carbonate unit within the plastic clays of the Keuper facies, has traditionally been attributed to the Muschelkalk facies. In the absence of palaeontological data, this carbonate unit has been adscribed to the lower Ladinian–Carnian age interval via correlation with the Pyrenean series (Calvet *et al*., 1993). This assumption has led to place the western margin of the Ladinian Tethys transgression in the area of Reinosa (Cantabria).

New palynological data from the Buntsandstein facies of the Reinosa (Cantabria) and Verbios (north of Palencia province) areas (Fig. 2) now suggests a Ladinian-Carnian age for the upper part of the Buntsandstein (Sánchez-Moya *et al*., 2005). This questions the correlation and equivalence of the middle carbonates that appear in this region with the Muschelkalk of the rest of Spain. The aim of this work is to define more precisely the age of the upper Buntsandstein facies based on palynological data and on isotopic data from the overlying carbonates, and thus better understand the palaeogeography of the western Tethys Triassic in this area.

2. Structural framework

Different episodes of extensional tectonics associated with the opening and propagation of the Tethys Sea towards the west during the Triassic, as well as the opening of the North Atlantic, were recorded in the western border of the Cantabrian Mountains, Spain and other nearby areas. The Cantabrian Mountains are a segment of the Pyrenees that emerged to the west of the Pamplona Fault. Three areas of the Cantabrian Mountains are recognisable: the eastern area (Basque-Cantabrian Basin, in Fig. 1), the central or Asturian Massif, and the western area (Barnolas and Pujalte, 2004). The Basque-Cantabrian Basin has three different domains; from east to west, these are: the Basque Arch, the Navarrese-Cantabrian Trough, and the North Castilian Platform (Barnolas and Pujalte, 2004).

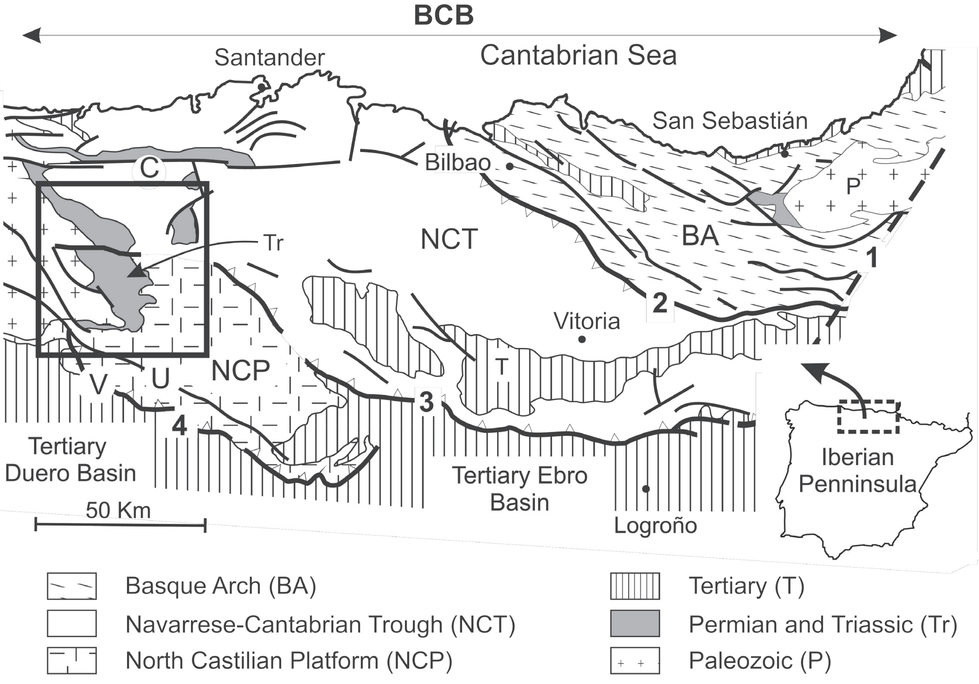

Fig. 1.- The Cantabrian Mountains and their main Triassic outcrops. Square: Study area (see figure 2 for more detail). BCB: Basque-Cantabrian Basin. 1: Pamplona Fault. 2: Bilbao-Alsásua Fault. 3: Duero Thrust. 4: Ebro Thrust. V: Villela Fault. U: Ubierna Fault. C: Cabuérniga Fault.

Fig. 1.- Principales afloramientos triásicos de la Cordillera Cantábrica. Recuadro: área estudiada (ver Figura 2 para mayor detalle). BCB: Cuenca Basco-Cantábrica. 1: Falla de Pamplona. 2: Falla de Bilbao-Alsásua. 3: Cabalgamiento sobre la Cuenca del Duero. V: Falla de Villella. U: Falla de Ubierna. C: Falla de Cabuérniga.

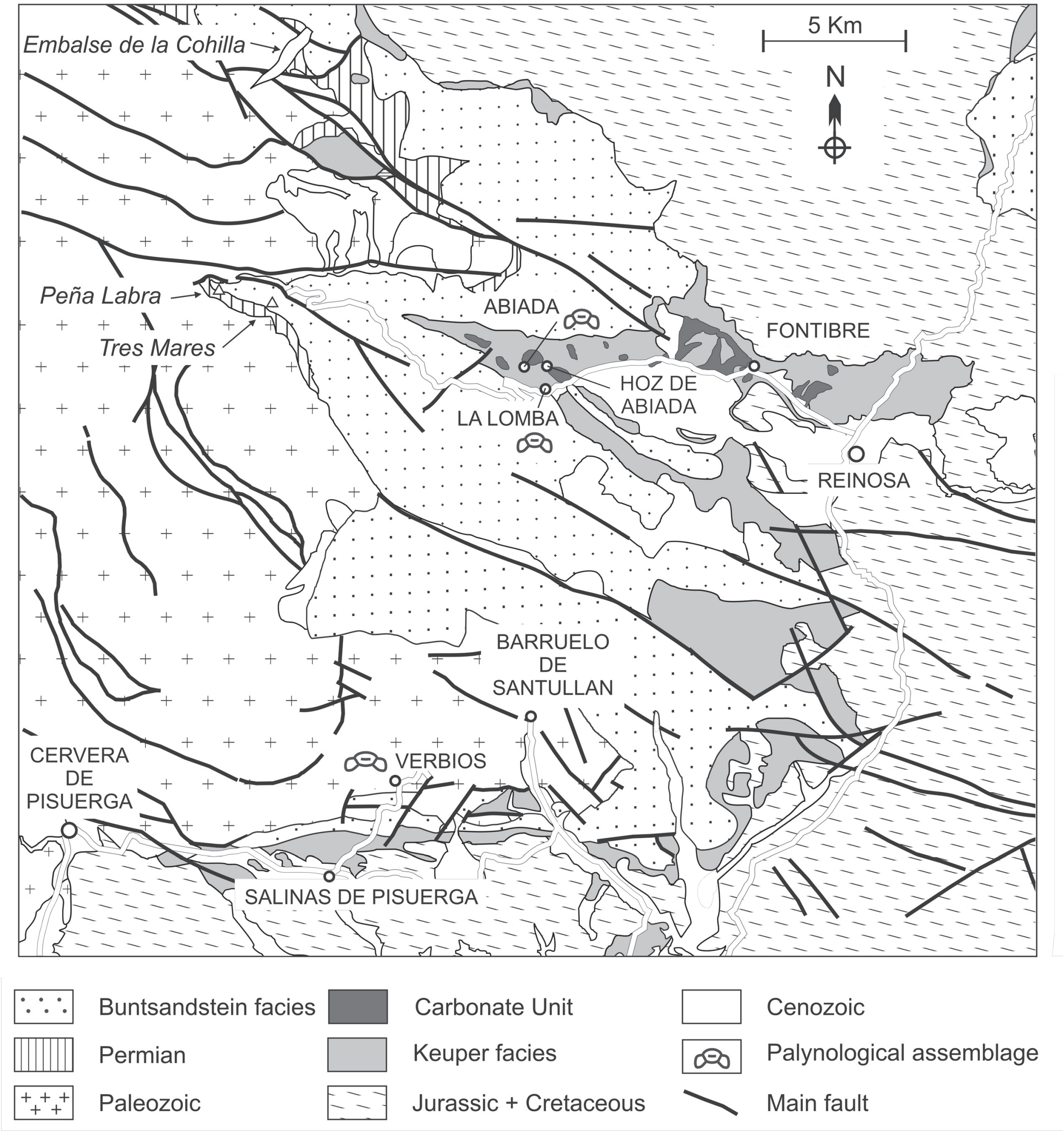

Fig. 2.- Simplified sketch map of the study area.
Fig. 2.- Mapa simplificado de la región estudiada.

The outcrops of the Buntsandstein facies in Cantabria and to the north of Palencia can be considered the logical border between the Basque-Cantabrian Basin and the Asturian Massif. In this sector, normal WNW-ESE faults have been recognized (Espina, 1992, 1997). The different growth of these faults determined very important changes in the thickness of the Triassic rocks preserved in the different basin sectors.

The study area (Fig. 2) is hosts to two well-differentiated domains: the southern sector around Cervera de Pisuerga-Verbios, and the central sector around Peña Labra-Reinosa. In the southern sector, the triassic rocks are thinner (150 m) because the sedimentation was developed on the stable margin. At that time, the central sector acted as a depocentre for the basin. However, the Triassic sequence reaches up to 900 m in thickness in the river Nansa section near of the Embalse de la Cohilla (Fig. 2). The tectonic activity is attested to the presence of angular unconformities of local extension. These unconformities are probably related to tilting and the development of the normal fault system (Espina, 1997).

3. Stratigraphic and sedimentological setting

The classic Germanic lithostratigraphic tripartition characterizes, according Robles and Pujalte (2004), the Triassic succession in the Cantabrian Mountains. The units are grouped as lower or Buntsandstein, middle or Muschelkalk, and upper or Keuper. Unlike other areas, e.g. Asturias, where it is difficult to distinguish the Permian from the Early Triassic, both successions are easily identified in the western part of the Basque-Cantabrian Basin (Cantabria and to the north of Palencia). In this area, the Triassic succession rests unconformably on lower Permian or Carboniferous rocks (Martínez-García, 1991; Robles and Pujalte, 2004). The age of Buntsandstein in this area is thought to be Early Triassic (Maas, 1974; García-Mondejar *et al.*, 1986; Martínez-García, 1991; Gand *et al.*, 1997). The unique pollen and spore assemblages found in the so-called "unidad de tránsito" to the Jurassic carbonate sediments (Suárez-Vega, 1974, Martínez-García, 1991), indicate a Rhaetian age (Martínez-García *et al.*, 1998; Barrón *et al.*, 2002).

The Buntsandstein of the Basque-Cantabrian Basin's western margin consists of an alternation of conglomerates and red sandstones plus mudstones, forming a positive macrosequence of fluvial origin. In the Verbios section of the southern domain (Fig. 3, see location in Fig. 2), the Buntsandstein is 245 m thick and shows a "basal conglomerate" bed followed by fine grain sandstones and mudstones with planar and trough cross bedding and parallel lamination. The upper part of the sequence is composed mainly of red mudstones and fine grained sandstones with flaser, wavy or lenticular bedding. The single palynological assemblage found in this region (sample 1349; Fig. 3) is located within these levels. The section has no carbonate deposits that can be attributed to the Muschelkalk. Thus, the Keuper facies apparently lie on the Buntsandstein.

In the Peña Labra-Tres Mares area (Fig. 2), the Buntsandstein sequence is thicker reaching nearly 650 m. In this area, the Alto Campóo Formation was attributed to Buntsandstein by Espina (1997), who divided the Formation into four units. More recently, Robles and Pujalte (2004) proposed its subdivision into three informal lithological units, which seem to the authors of the present paper a more reliable subdivision. The first one (Fig. 3, B1), the maximum thickness of which is about 80 m, consists of conglomerates poorly sorted and well rounded quartz-rich components. The second unit is a macrosequence, about 300 to 500 m composed of red sandstones, white conglomeratic sandstones and siltstones, lies over the conglomerate unit (Fig. 3, B2). This macrosequence can be subdivided into several minor ones. The first one is a coarsening-upwards 40 m thick sequence and may represent a reactivation of the fluvial system. Several levels formed of conglomerates to white sandstone and red mudstone between 6 and 9 m thick appear, forming it. Abundant plant remains are found in the sandstones levels. A set of sequences forming a finning-upward macrosequence was then deposited. These sequences are composed mainly by sandstones and mudstones, with subordinate conglomerates. The individual bodies show abundant primary bed forms and a variety of architectural elements. A remarkable soil horizon lies at the top of the macrosequence. The topmost Buntsandstein unit (Fig. 3, B3) is 65 m thick and is mainly composed of muddy facies with subordinate sandstones. Within this unit, two palynological assemblages are found (samples 1410 and 1379; Fig. 3).

A carbonate unit lies in tectonic contact above the Buntsandstein (see Fig. 2 for location); this has been assigned to the Muschelkalk (Carreras *et al.*, 1979; García-Mondéjar *et al.*, 1986; López-Gómez *et al.*, 2002; Robles and Pujalte, 2004) but it has not been dated. The unit has been attributed to the lower Ladinian-Carnian via sequential correlation with Pyrenean successions. Its maximum thickness is close to 125 m. Its lower and upper boundaries are always mechanical contacts that prevent tracing accurately the original lateral continuity. The most complete outcrops in the area lie northwest of Reinosa (Fig. 2). The carbonate unit is formed by two units: a lower one made up of of grey limestone and an upper one of limestone and dolomites. The former shows a variety of facies from oolitic grainstones to bioclastic wackestones, laminated algal strata, and evaporite with mouldic porosity. These facies are locally organized in metric shallowing upward sequences. The upper unit is partially dolomitized and formed by mudstones, wackestones and dolomicrites. Fossils are scarce (mainly small gastropods, remains of bivalves, ostracods and echinoderm fragments) and are found in layers a few centimetres thick (lumachelle beds). The whole carbonate unit is thought to has been deposited on an essentially internal and not very deep carbonated ramp.

The Keuper facies corresponds to a regressive cycle prior to the Upper Triassic transgressive episode. Although tectonic and halokinetic processes make it difficult to establish a type section, the Keuper succession is typically composed of reddish, blue and green mudstone with intercalations of evaporites, such as gypsum, anhydrite, and carbonated beds (mainly dolomites) in the upper part of the succession. The Keuper deposits have been interpreted as deposed in sabkha environment (Robles and Pujalte, 2004). Locally toleitic basalt (ofite) occurs. The Keuper pass upward progressively to a dolomitic unit interpreted as Rhaetian in age (Martínez-García *et al.*, 1998; Barrón *et al.*, 2002).

4. Age: Palynology and isotope data.

Palaeontological data from the Triassic rocks of the Cantabrian Mountains are scarce (Maas, 1974; Demathieu and Sainz de Omeñaca, 1977). The Buntsandstein

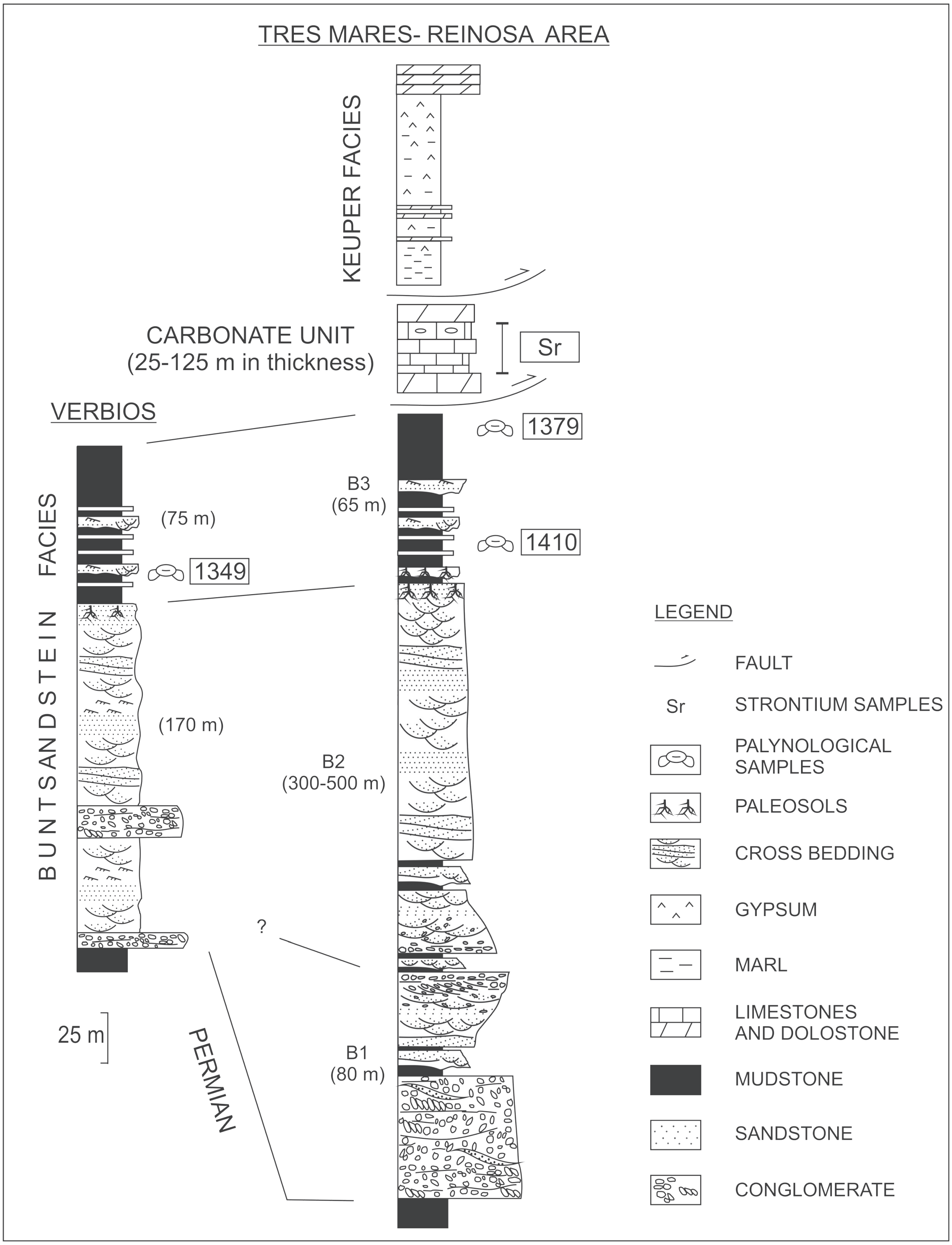

Fig. 3.- Simplified Triassic section at Verbios and Tres Mares-Reinosa area.
Fig. 3.- Columnas estratigráficas tipo de las regiones de Verbios y Tres Mares-Reinosa.

facies has been attributed to the Induan-Anisian (Robles and Pujalte, 2004). Only the lowest Buntsandstein facies that unconformably overlays Permian or Carboniferous rocks have been assigned to the Upper Permian (see Robles and Pujalte, 2004). Traditionally, the stratigraphic position of carbonate units and their regional correlation with the equivalent successions of the Pyrenees based on sequence stratigraphy have been used to attribute ages to the different units. The carbonates that appear near Reinosa have been considered as Ladinian-lower Carnian, and the Keuper facies has been assigned a Carnian age. Finally, several palynological associations found in the upper Triassic series have been described, and allow a Rhaetian age for the "unidad de transito" (Suárez-Vega, 1974). Since the end of the nineties, typical Rhaetian palynological assemblages have been described in Asturias (Martínez-García *et al*., 1998; Barrón *et al*., 2002, 2006). The study of these assemblages has allowed to establish the Triassic-Jurassic boundary in the area (Barrón *et al*., 2006).

4.1. Palynological features of the Cantabrian Buntsandstein

Samples (n=25) of grey and black shales were prepared following the Batten (1999) method based on acid attack (HCl, HF, HNO$_3$) at high temperature. These samples were collected from sediments of the upper Buntsandstein in the area of Verbios, Salinas de Pisuerga, Tres Mares, la Lomba, Abiada and Hoz de Abiada localities (Fig. 2). Only three samples yielded useful results (Fig. 3). The majority of the miospore taxa are quite usual in European Triassic assemblages and have been sufficiently treated in classical taxonomic works (Leschik, 1956; Klaus, 1964; Mädler, 1964; Scheuring, 1970, 1978) and in other studies such as Van der Eem (1983), Roghi (2004) and Traverse (2007). The studied palynomorphs underwent high thermal maturity during the diagenetic process. For this reason, they have dark orange-brown colours (Fig. 4) that correspond to 17,209–15,14A on the Munsell colour chart (see Traverse, 2007, Fig. 19.2).

Samples 1349 (Verbios section) and 1410 (Abiada Section), showed similar assemblages (Table 1) with high percentages of bisaccate pollen grains (73.36% and 76.11%, respectively), and small amounts of circumpolles (13.57% and 17.32%, respectively) and inaperturate (12.27% and 5.51%, respectively) grains. Monosulcate, trisulcate and monosaccate pollen grains were very scarce. Sample 1379 showed lower percentages of bisaccate and inaperturate pollen grains (52.65% and 4.34% respectively) than the two previous samples, and a higher percentage of circumpolles (37.19%). Monosulcate and monosaccate pollen grains as well as trilete spores were scarce.

The following taxa were identified in the three samples: *Alisporites* sp. (Fig. 4g), *Cycadopites* sp., *Duplicisporites verrucosus* (Fig. 4a), *D. tenebrosus*, *Ginkgocycadophytus nitidus* (Fig. 4c), *Inaperturopollenites* sp., *Triadispora sulcata*, *Triadispora* spp., *Vitreisporites* sp. (Fig. 4e) and undetermined bisaccate pollen grains and circumpolles. The occurrence of *Duplicisporites* indicates that the studied samples cannot be older than the Ladinian since this genus is first recorded during this period (Visscher and Brugman, 1981; Schulz and Heunisch, 2005).

Sample 1410 is important by the presence of *Eucommiidites microgranulatus*. According to Schulz and Heunisch (2005), the presence of this species indicates a Ladinian–lower Carnian age. Neither typical Late Ladinian species such as *Echinitosporites iliacoides* and *Heliosaccus dimorphicus* and Lower Carnian ones, such as *Partitisporites quadruplices*, were no found in the studied samples. So, in agreement with Visscher and Brugman (1981) and Warrington (1996), no precise age can be inferred, although several authors, such as Calvet *et al.* (1993) assign a Ladinian age to Pyrenean assemblages due to the lack of typical Carnian taxa.

As the high percentage of bisaccate pollen grains indicates, the studied assemblages were composed of palynomorphs with long-distance wind dispersal (mainly conifers and pteridosperms) which surely represent regional vegetation. It appears highly probable that all these pollens were originated in different environments since conifers inhabited environments of diverse ecological conditions including dry, saline or upland areas (Vakhrameev, 1991; Abbink *et al*., 2004), whereas seed-ferns are assumed to grow in moist-lush vegetation, mangroves and tidally influenced environments (Van Konijnenburg-Van Cittert and Van der Burgh, 1993).

In addition, the predominance of bisaccate pollen grains could be in tune with a Ladinian age for the samples 1349 and 1410, since these pollens dominate the Ladinian assemblages from the Pyrenees (Fréchengues *et al*., 1993), the Catalan Coastal Range (Solé de Porta *et al*., 1987) and the Iberian ranges (Doubinger *et al*., 1990; Sopeña *et al*., 1995).

From the Ladinian onward, a gradual increase of circumpolles can be found in the Triassic assemblages of the Iberian Peninsula. So, the assemblage of sample 1379 (La Lomba section), which shows a higher percentage of circumpolles than the two oldest, could be related to the upper Ladinian of the Castilian branch of the Iberian Ranges (Sopeña *et al*., 1995) and the Carnian of Formation Miravet, Prades area, Catalonia (Solé de Porta *et al*., 1987).

4.2. Strontium isotope data

Several limestone samples from the carbonate unit (Fig. 3) were analysed by the Geochronology and Isotopic Geochemistry Laboratory of the Complutense University (Madrid, Spain). Previous analyses indicate that these samples to be very pure, 94%-98% CaCO$_3$, and no petrological evidences of dolomitization has been observed. The values for Sr were corrected for possible isobaric interference from ^{87}Rb and normalized to the value Sr/^{88}Sr = 0.1194. During analysis, the isotopic standard NBS-987 was measured and a half value of 0.710285 ± 0.00004 obtained at level 2a for the ^{87}Sr/^{86}Sr ratio for a number of data of n=7. This coincides with the value obtained for the same standard in the laboratory (0.710254

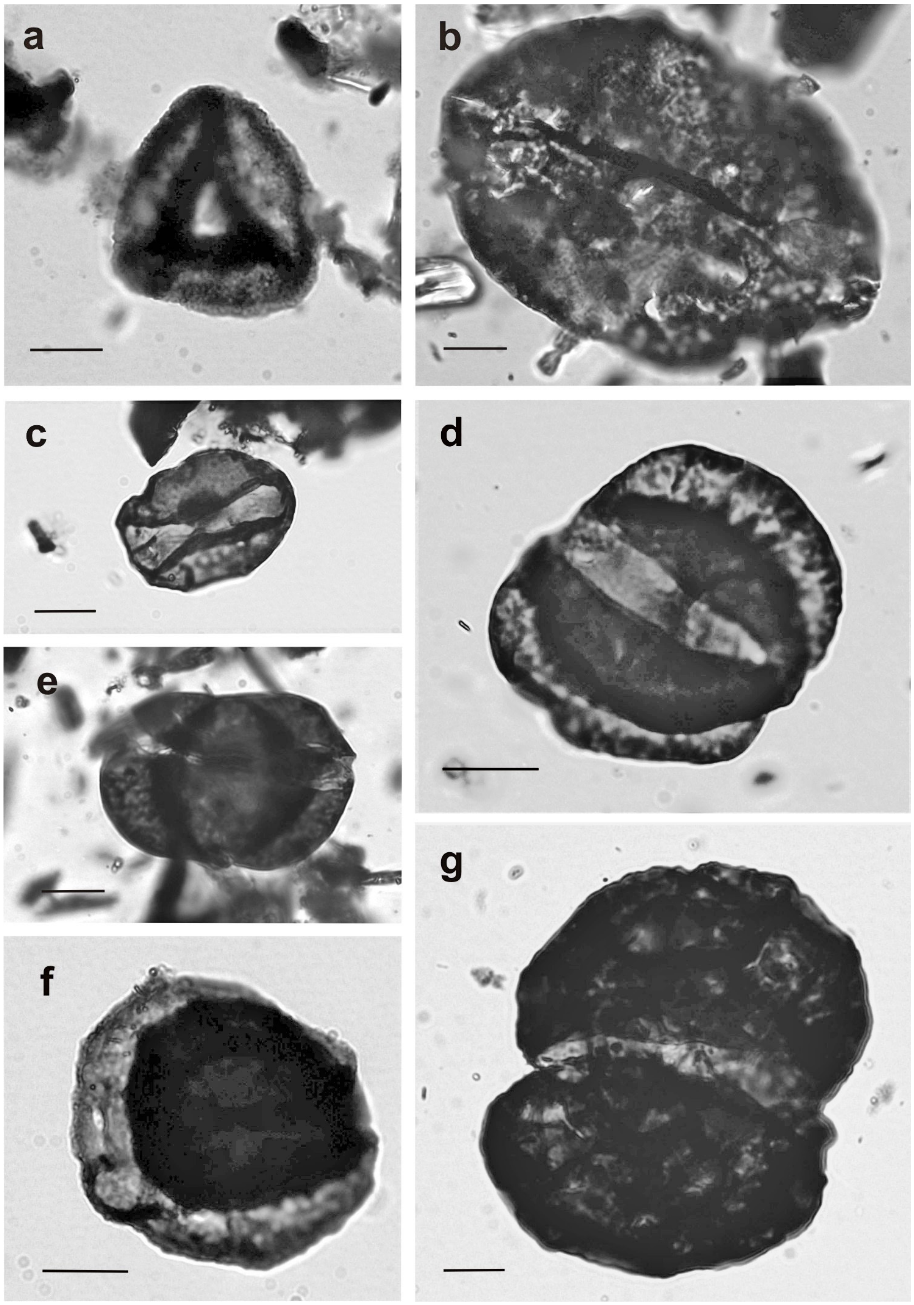

Fig. 4.- Pollen types of the Middle-Upper Triassic at Tres Mares-Reinosa and Verbios: a) *Duplicisporites verrucosus* (Leschik 1955) Scheuring 1970, level 1349, b) *Ovalipollis pseudoalatus* (Krutzsch 1955) Schuurman 1976, level 1349, c) *Ginkgocycadophytus nitidus* (Balme 1957) de Jersey 1962, level 1379, d) *Triadispora sulcata* Scheuring 1978, level 1410, e) *Vitreisporites* sp., level 1410, f) *Accinctisporites* sp., level 1379, g) *Alisporites* sp., level 1379. Graphic scale = 10 µm.

Fig. 4.- Tipos polínicos del Triásico Medio-Superior de Tres Mares-Reinosa y Verbios; a) *Duplicisporites verrucosus* (Leschik 1955) Scheuring 1970, nivel 1349, b) *Ovalipollis pseudoalatus* (Krutzsch 1955) Schuurman 1976, nivel 1349, c) *Ginkgocycadophytus nitidus* (Balme 1957) de Jersey 1962, nivel 1379, d) *Triadispora sulcata* Scheuring 1978, nivel 1410, e) *Vitreisporites* sp., nivel 1410, f) *Accinctisporites* sp., nivel 1379, g) *Alisporites* sp., nivel 1379. Escala gráfica = 10 µm.

± 0.00004). The analytical error for the $^{87}\mathrm{Sr}/^{86}\mathrm{Sr}$ ratio was 0.01%. Statistical regression was performed using LOWESS (Locally Weighted Scatterplot Smoother) V3 software (Cleveland, 1979; Chambers *et al*., 1983; Thisted, 1988; Cleveland *et al.,* 1992) to obtain numerical ages with 95% confidence limits for any given $^{87}\mathrm{Sr}/^{86}\mathrm{Sr}$ value (McArthur *et al*., 2001). Figure 5 shows the obtained $^{87}\mathrm{Sr}/^{86}\mathrm{Sr}$ values and the estimated ages of the sediments. The

Samples	1349	1410	1379
Trilete spores of vascular cryptogamae			
Deltoidospora tenuis (Leschik 1955) Mädler 1964			1
Todisporites sp.			1
Undetermined trilete spores			2
Gymnosperm pollen			
Inaperturate pollen			
Inaperturopollenites sp.	47	21	18
Circumpollen			
Duplicisporites verrucosus (Leschik 1955) Scheuring 1970	3	2	2
Duplicisporites scurrilis (Scheuring 1970) Scheuring 1978	1	1	
Duplicisporites tenebrosus (Scheuring 1970) Scheuring 1978	1	1	2
Duplicisporites sp.			9
Praecirculina granifer (Leschik 1956) Klaus 1960	1		3
Undetermined circumpolles	46	62	138
Monosaccate pollen			
Accinctisporites sp.			11
cf. *Cyclosaccus* sp.	1		
cf. *Patinasporites* sp.			1
Bisaccate pollen			
Alisporites sp.	6	6	8
Lunatisporites sp.			1
Microcachryidites fastidioides (Jansonius 1962) Klaus 1964	3	1	
Triadispora falcata Klaus 1964	1		
Triadispora modesta Scheuring 1970		1	
Triadispora sulcata Scheuring 1978	4	1	1
Tridispora stabilis Scheuring 1970 emend. Scheuring 1978			2
Triadispora suspecta (Scheuring 1970) Scheuring 1978		1	
Triadispora spp.	1	3	6
Undetermined bisaccate pollen grains	260	270	198
Vitreisporites pallidus (Reissinger 1950) Nilsson 1958		6	1
Vitreisporites sp.	6	1	1
Ovalipollis group			
Ovalipollis pseudoalatus (Krutzsch 1955) Schuurman 1976		1	1
Sulcate pollen			
Cycadopites sp.	1	1	6
Eucommiidites microgranulatus Scheuring 1970		1	
Ginkgocycadophytus nitidus (Balme 1957) de Jersey, 1962	1	1	1
Total miospore number	283	294	414

Table I.- List of taxa recorded in the studied samples.
Tabla I.- Relación de los taxones presentes en las muestras estudiadas.

^{87}Sr/^{86}Sr ratios (0.707769-0.707834) are compatible with Norian age or the Norian-Rhaetian boundary. As the underlying fine size sediments from unit 3 contained palynological assemblages from the Ladinian- lower Carnian interval, a lower Triassic age for the carbonate unit can reasonably be ruled out.

4.3 Discussion

If a Norian age for the intermediate limestone studied is assumed, it is necessary to discard the possibility that these levels are equivalent to the Muschelkalk of other places in the Iberian Peninsula. It should be noted that the lower Muschelkalk in Spain is always Anisian in age and corresponds to the first Tethys cycle transgression (Sopeña *et al.* 1988), while the middle transgression of the latter is of Ladinian in age. The ladinian transgression was more widespread than that of the Anisian, and traditionally the carbonate unit of the study area has been assigned to stage. In the light of the available data, the carbonate unit does not appear to correspond to the Muschelkalk because it appears to be younger than the

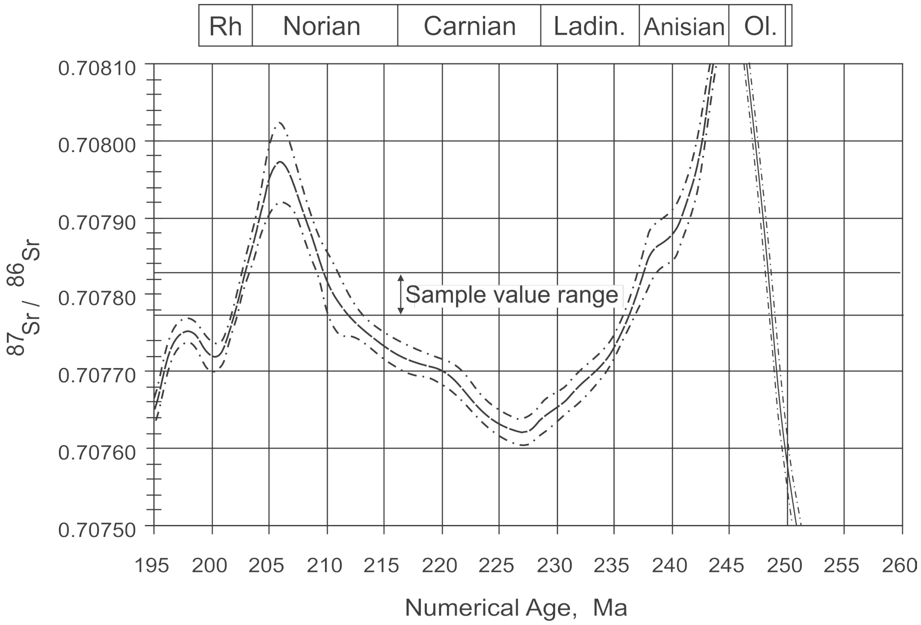

Fig. 5.- Strontium isotope data for the carbonated unit and their attributed age (LOWESS, courtesy of McArthur *et al*., 2001). The solid line represents the 100% value. Dotted lines represent the 95% CI level.

Fig. 5.- Datos isotópicos de las facies calcáreas y posibilidades de atribución de edad. (LOWESS, por cortesia de McArthur *et al*., 2001). La línea continua representa el valor del 100% del valor de confianza. Las lineas discontinuas representan el 95 %.

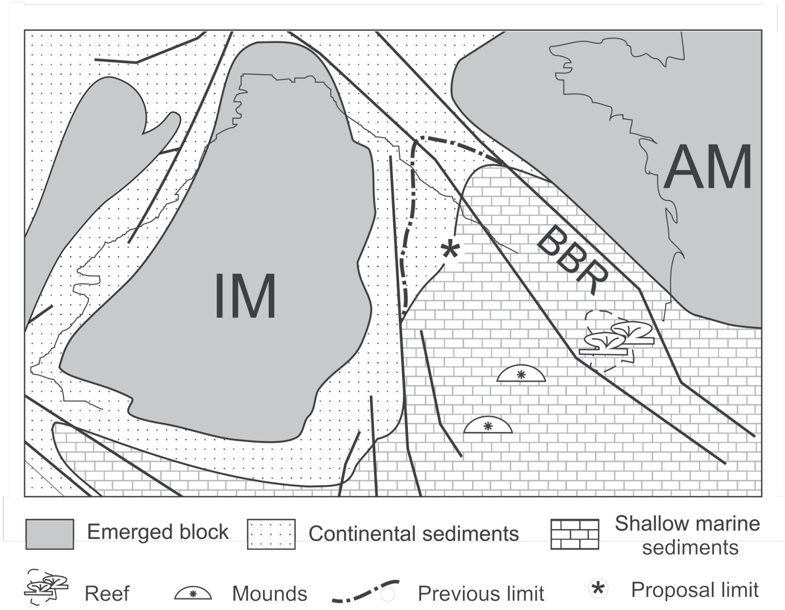

Fig. 6.- Palaeogeographic sketch map showing the distribution of continental and marine deposit in the Cantabria area for the Middle Triassic. IM: Iberian Massif; AM: Armorican Massif. BBR: Bay Biscay Rift. Geomorphic and previous palaeogeographic sketch according several authors (Sopeña *et al.* 1988, Dercourt *et al*. 1993, Stampfli *et al*., 2001).

Fig. 6.- Esquema paleogeográfico de distribución de sedimentos marinos y continentales en la zona Cantábrica durante el Triásico Medio. IM: Macizo Ibérico; AM: Macizo armoricano; BBR: *Rift* de la Bahía de Vizcaya. Esquema paleogeográfico previo modificado de varios autores (Sopeña *et al*. 1988, Dercourt *et al*. 1993, Stampfli *et al.*, 2001).

first two Triassic transgressive episodes in the Tethys.

This conclusion is of palaeogeographic significance since it suggests that the edge of the Triassic Tethys for the Ladinian transgression traditionally located near Reinosa (Cantabria) should be revised and moved further to the East, between Bilbao and San Sebastián (Fig. 6) where there are clear indications of ladinian deposits (Calvet *et al.*, 1993, 1994).

5. Conclusions

The stratigraphic position of the horizons layers that contain the palynological assemblages indicates that, in the study region, the upper part of Buntsandstein is Ladinian to Carnian in age, contemporaneous with the carbonates of the upper Muschelkalk facies of other areas of the Iberian Peninsula, and even of lower part of the Keuper facies that appear, for example, in the Iberian Range.

The lithofacies and fossils of the carbonate unit located in the vicinity of Reinosa (Cantabria) and previously attributed to Muschelkalk, are very different from those of the upper Muschelkalk of other parts of Spain. Moreover, the $^{87}Sr/^{86}Sr$ ratios of limestone samples from this carbonated unit are in tune with a Norian age or the Norian-Rhaetian boundary.

These new data, questions the stratigraphic attribution of the carbonate unit to the Ladinian-lower Carnian by correlation with the Triassic of the Pyrenees and also questions the assumed correlation of the carbonate facies in the surroundings of Reinosa with the Muschelkalk facies of other areas of the Iberian Peninsula. Instead, the carbonate unit could be correlated with similar sections of the Pyrenees Norian-Rhaetian sediments (Isábena Formátion and Imón Fomation).

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