Characterization and planktonic foraminifera biostratigraphy of the transition Black Flysch Group -Calcareous Flysch between Usurbil and Hernani, westernmost Pyrenees

Caracterización y bioestratigrafía de foraminíferos planctónicos de la transición del Grupo Flysch Negro - Flysch Calcáreo entre Usurbil y Hernani, Pirineo occidental

Arantxa Bodego [1], Eneko Iriarte [2] y Luis Miguel Agirrezabala [3]

[1] Meatze eta Metalurgia Ingenieritza eta Materialen Zientzia Saila, Topografia atala, Nieves Cano 12, 00106 Vitoria-Gasteiz. arantxa.bodego@ehu.es
[2] Institución Milà i Fontanals-CSIC, Dpto. Arqueología y Antropología, C/ Egipcíaques 15, 08001 Barcelona. eneko.iriarte@imf.csic.es
[3] Estratigrafia eta Paleontologia Saila. Euskal Herriko Unibertsitatea, 644 p.k., 48080 Bilbao. l.agirrezabala@ehu.es

RESUMEN

La realización de una cartografía de detalle junto al análisis sedimentológico y bioestratigráfico del contacto entre las unidades del Grupo Flysch Negro y el Flysch Calcáreo entre las localidades de Usurbil y Hernani ha permitido caracterizar el tránsito entre ambas unidades estratigráficas. Los datos indican la existencia de una disconformidad entre ambas unidades y no un contacto por falla inversa tal y como habían sugerido autores anteriores. Un análisis bioestratigráfico de detalle de las rocas subyacentes y suprayacentes al contacto deposicional indica la presencia de un hiato de duración variable a lo largo del mismo: en el sector oeste un hiato intra-Zona R. globotruncanoides (Cenomaniense Inferior) y en el sector este un hiato entre las Zonas R. appenninica – R. globotruncanoides (Albiense Superior-Cenomaniense Inferior).

Key words: *Planktonic foraminifera, Black Flysch Group, Calcareous Flysch, Basque-Cantabrian Basin.*

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Introduction

In the NW margin of the Bortziri (Cinco Villas) Palaeozoic Massif (NE Basque-Cantabrian Basin), Late Albian to Cenomanian materials crop out (Fig. 1). The Late Albian - Early Cenomanian deposits, mainly composed of alternating lutites and sandstones and megabreccia, belong to the Black Flysch Group (Souquet *et al.*, 1985). The Calcareous Flysch, mainly comprises Upper Cretaceous hemipelagic marls and limestones. Many authors reached different conclusions for the contact between the Black Flysch Group and the Calcareous Flysch. Lamare (1936), Feuillée & Sigal (1965), Feuillée (1967) and EVE (1991) proposed a depositional contact based on a section no more available in the Añorga-Aundi quarry

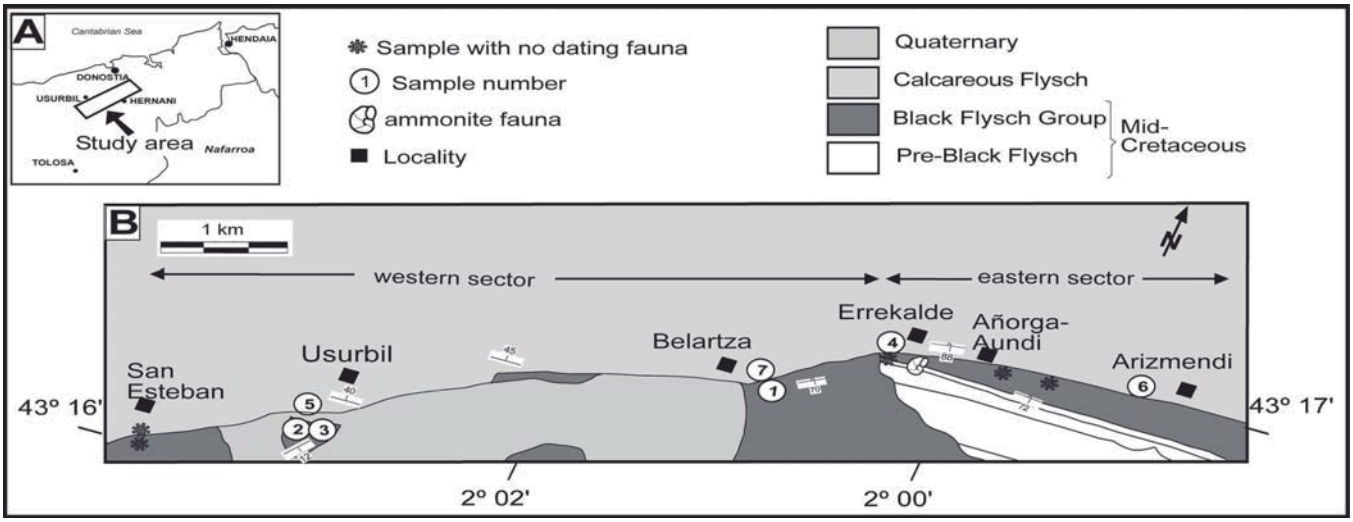

Fig. 1.- (A) Location map of the studied area. (B) Schematic geologic map of the contact and location of the most significant studied samples.

Fig. 1.- (A) Localización del área de estudio. (B) Mapa geológico esquemático del contacto y situación de las muestras más significativas.

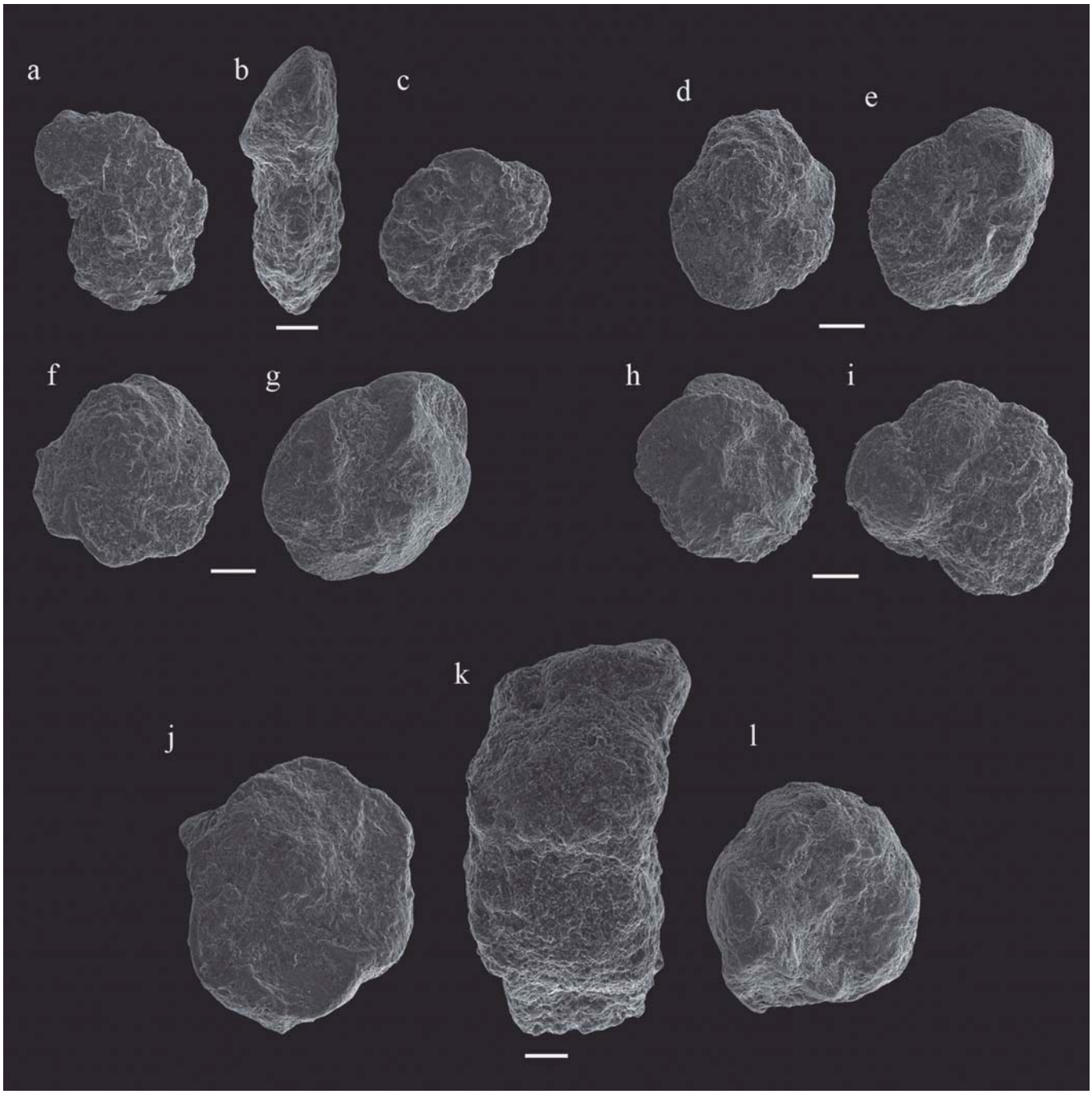

Fig. 2.- SEM images of planktonic foraminifera. (a-c) *Planomalina buxtorfi* Gandolfi; (a) spiral view; (b) edge view; (c) umbilical side; (d,e) *Rotalipora globotruncanoides* Sigal; (d) spiral view; (e) umbilical view; (f,g) *Rotalipora greenhornensis* Morrow; (f) spiral view; (g) umbilical view; (h,i) *Rotalipora ticinensis* Gandolfi; (h) spiral view; (i) umbilical view; (j-l) *Rotalipora micheli* Sacal & Debourle; (j) spiral view; (k) edge view (l) umbilical view. Scale bars: 100 μm.

Fig. 2.- Imágenes MEB de foraminíferos planctónicos. (a-c) Planomalina buxtorfi Gandolfi; (a) vista espiral; (b) vista lateral; (c) vista umbilical; (d,e) Rotalipora globotruncanoides Sigal; (d) vista espiral; (e) vista umbilical; (f,g) Rotalipora greenhornensis Morrow; (f) vista espiral; (g) vista umbilical; (h,i) Rotalipora ticinensis Gandolfi; (h) vista espiral; (i) vista umbilical; (j-l) Rotalipora micheli Sacal & Debourle; (j) vista espiral; (k) vista lateral (l) vista umbilical. Barras de escala: 100 μm.

(few km south of Donostia). However, Campos (1979) and Mathey (1987) evoked a tectonic contact along the inverse «Usurbil Fault» due to the basin inversion in the Tertiary. Reaching different conclusions is probably due to scarce outcrops along the contact, scarce ammonites and poorly preserved planktonic foraminifera. Recently, the high rate of urbanization in the area has allowed new outcrops providing new data along the Black Flysch Group-Calcareous Flysch boundary.

The aim of this work is to discriminate the nature (depositional or tectonic) of the contact in the study area based on datation of the underlying and overlying materials. Mapping of the area, stratigraphic and sedimentological characterization of outcrops and biostratigraphy and datation of planktonic foraminifera across the transition were carried out in order to determine the character of the contact.

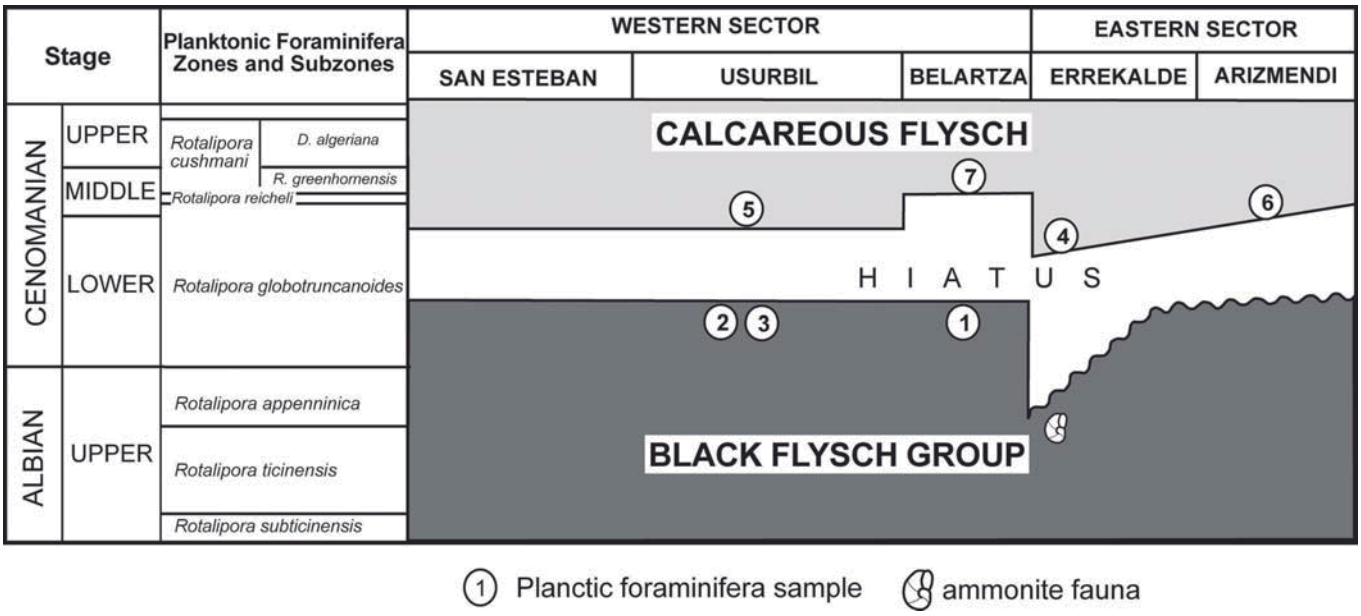

Fig. 3.- Biostratigraphic chart between San Esteban and Arizmendi localities, based on planktonic foraminifera (modified from Ogg, J.G. *et al*., 2004).

Fig. 3.- Cuadro bioestratigráfico basado en biozonaciones de foraminíferos planctónicos entre las localidades de San Esteban y Arizmendi (modificado de Ogg, J.G. et al., 2004).

Results

The contact at studied outcrops is sharp and erosive and presents absence of mesoscopic tectonic structures such as shear surfaces, fractures, veins or folds. In the eastern sector, mapping shows evidence of an angular unconformity along the contact while in the western sector the contact between the Black Flysch Group and the Calcareous Flysch is apparently concordant.

The biostratigraphic analysis of the samples was elementary in order to determine the age of the sample (Fig. 2). In addition to this, few ammonite specimens were collected at the top of the Black Flysch Group at the Errekalde outcrop, which date the *S. dispar* ammonite Zone (unpublished data).

Black Flysch Group samples

Sample 1: it is from Lasarte Megabreccia blocks (Bodego *et al*., 2008). The sample is composed of *Rotalipora appenninica* (Renz), *Rotalipora ticinensis* (Gandolfi), *Planomalina buxtorfi* (Gandolfi), *Muricohedbergella delrioensis* (Carsey), *Muricohedbergella sinplex* (Morrow) and *Praeglobotruncana delrioensis* (Plummer). This assemblage corresponds to the *Rotalipora appenninica* Zone which dates the late Late Albian. Therefore, it predates megabreccia deposits.

Sample 2: it is composed of *R. appenninica, R. ticinensis, P. buxtorfi, M. delrioensis*. This association also indicates the *R. appenninica* Zone, dating the late Late Albian.

Sample 3: this association is dominated by *Rotalipora globotruncanoides* (Sigal), *Rotalipora micheli* (Sacal & Debourle) and *Muricohedbergella* sp. (Verga & Premoli Silva). This association is indicative of the *Rotalipora globotruncanoides* Zone, which dates the Early Cenomanian.

Calcareous Flysch samples

Sample 4: *R. globotruncanoides*, *Rotalipora montsalvensis* (Mornod) and *Macroglobigerinelloides* sp. (Verga & Premoli Silva) compound this assemblage. These species characterize the upper part of the *R. globotruncanoides* Zone, which indicates the early Mid Cenomanian.

Sample 5: comprises *R. globotruncanoides, R. montsalvensis, Macroglobigerinelloides* sp., *P. buxtorfi* and *R. appenninica*. This association (except *P. buxtorfi*) indicates an early Mid Cenomanian age. The presence of *P. buxtorfi*, which dates the Late Albian, would be the product of reworked material.

Sample 6: composed of *Globigerinelloides* sp. (Cushman & ten Dam), *R. montsalvensis*, *R. micheli* and *Rotalipora reicheli* (Mornod), is indicative of the *Rotalipora reicheli* Zone. These date the Mid Cenomanian.

Sample 7: *R. appenninica, R. micheli, Rotalipora greenhornensis* (Morrow) and *R. montsalvensis* belong to the lower part of the *Rotalipora cushmani* Zone (*Rotalipora greenhornensis* Subzone), which dates the Mid to Late Cenomanian.

Discussion and Conclusions

Mapping of the contact and stratigraphic and sedimentological characterization of the contact outcrops indicate depositional contact (not tectonic) between the Black Flysch Group and the Calcareous Flysch. Moreover, mapping shows an angular unconformity between these two units at least in the eastern sector of the studied area (Fig. 1b).

Micropaleontologic analysis of the Black Flysch Group deposits below the contact suggests that these are lower Lower Cenomanian (*R. globotruncanoides* Zone) in the western sector (samples 1, 2 and 3). This age may probably be extrapolated to the westernmost San Esteban area (lateral equivalent beds), though dating planktonic foraminifers were not found in these deposits (Fig. 3). On the other hand, and based on ammonite specimens, the top of the Black Flysch Group is upper Upper Albian (*S. dispar* ammonite Zone) in the eastern sector.

The planktonic foraminifera associations of the basal deposits of the Calcareous Flysch indicate diachronism at the base of that unit. They range from uppermost Lower Cenomanian (upper *R. globotruncanoides* Zone) (samples 4, 5

and 6) to Middle Cenomanian (*R. Reicheli* Zone) in the Belartza area (sample 7) (Fig. 3).

The planktonic biostratigraphy of the Black Flysch and Calcareous Flysch transition indicates a hiatus at the contact between the units, as at least part of the Lower Cenomanian is missing in the whole area (Fig. 4) and also suggests diachronism in the eastern sector.

The entire Errekalde-Arizmendi area (eastern sector) crops out in the northern limb of the east-trending Errekalde faulted anticline (Lamare, 1936). Based on stratigraphic and sedimentological data, this area is interpreted to have acted as an uplifted area with low or none sedimentation while the western sector acted as a subsiding area where megabreccia deposited (Bodego *et al*., 2008) during the Late Albian - Early Cenomanian.

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