Preliminary paleomagnetic and paleocurrent data from the mid-Cretaceous Black Flysch Group, Western Pyrenees: tectonic implications

Datos paleomagnéticos y de paleocorrientes preliminares del Grupo Flysch Negro (Cretácico medio), Pirineo occidental: implicaciones tectónicas

L. M. Agirrezabala [1] y J. Dinarès-Turell [2]

[1] Estratigrafia eta Paleontologia Saila, Euskal Herriko Unibertsitatea, 644 P.K. Bilbo, Spain. E-mail: l.agirrezabala@ehu.es
[2] Istituto Nazionale di Geofisica e Vulcanologia. Via di Vigna Murata 605, 00143 Roma, Italy. E-mail: dinares@ingv.it

RESUMEN

Datos paleomagnéticos y de paleocorrientes preliminares correspondientes a depósitos turbidíticos en torno al monoclinal sinclinal de Aitzeta (margen norte de la Cuenca Vasco-Cantábrica) indican rotaciones de eje vertical de bloques de edad Albiense superior (Subzona C. auritus*) y terciaria (?). Los datos, combinados con los rasgos estructurales del área, evidencian una rotación antihoraria de ~27º (bloque de Deba) durante la Subzona* C. auritus*, y rotaciones antihorarias de ~27º y ~55º (bloques de Galdonamendi y Mizkia, respectivamente) y horarias de ~40º (bloque de Andutz) de edad terciaria (?). Los resultados obtenidos son coherentes y permiten reconstruir la compleja historia estructural y deposicional del área.*

***Key words**: Block rotation, paleomagnetism, paleocurrents, Cretaceous, Basque-Cantabrian Basin.*

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Introduction

The Cretaceous northern margin of the Basque-Cantabrian Basin (Fig. 1) was located on the southwestern European plate margin, which was created by the oblique opening of the Bay of Biscay rift. This rift margin was affected by major sinistral strike-slip deformation (e.g. Choukroune and Mattauer, 1978), which included the development of short-lived compressional tectonic structures like Aitzeta. Later Tertiary (Eocene) basin inversion caused northeastward thrusting and folding.

The Aitzeta monoclinal syncline is a Late Albian *C. auritus* Subzone deep-water transpressional fold associated with Mutriku fault (Agirrezabala *et al*., 2002, 2003) (Fig. 2). Anomalous preliminary paleocurrent data from adjacent pre-*auritus* turbidites (Agirrezabala, 1996) suggested possible counterclockwise vertical-axis rotation of the Deba block that would explain the Aitzeta contraction structure formation. With the object of lending support to possible *auritus* Subzone (syngrowth) vertical-axis rotations we acquired and analysed new paleomagnetic and paleocurrent data from pre- and post-*auritus* deposits of different domains around that structure.

Geological setting

The Black Flysch Group (Middle Albian - Middle Cenomanian) constitutes a deep-water siliciclastic unit deposited along the Pyrenean realm and northern margin and centre of the Basque-Cantabrian Basin (Souquet *et al*., 1985). In the northern margin of the basin, northeast-derived small, confined turbidite systems filled sub-basins with faulted and folded borders. Turbiditic dispersion systems and paleocurrents were parallel to

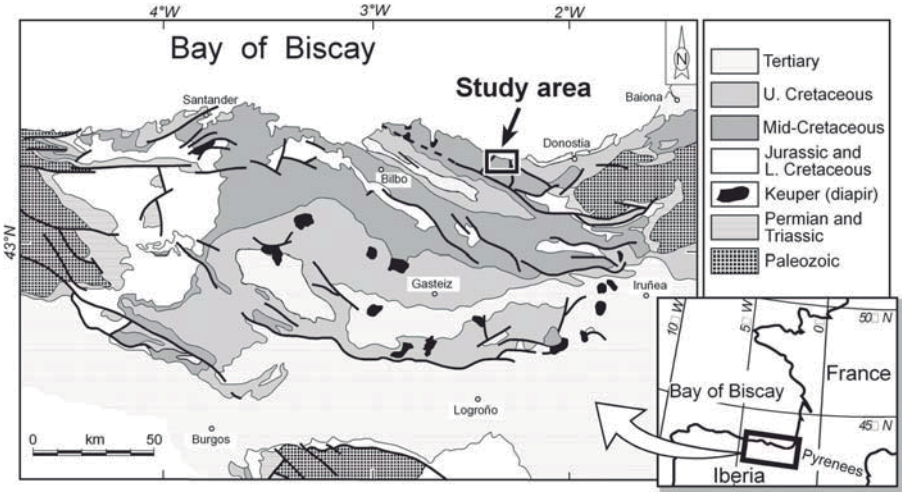


Fig. 1.- Geological map of the Basque-Cantabrian Basin and indication of the study area.

Fig. 1.- Mapa geológico de la Cuenca Vasco-Cantábrica con indicación del área estudiada.

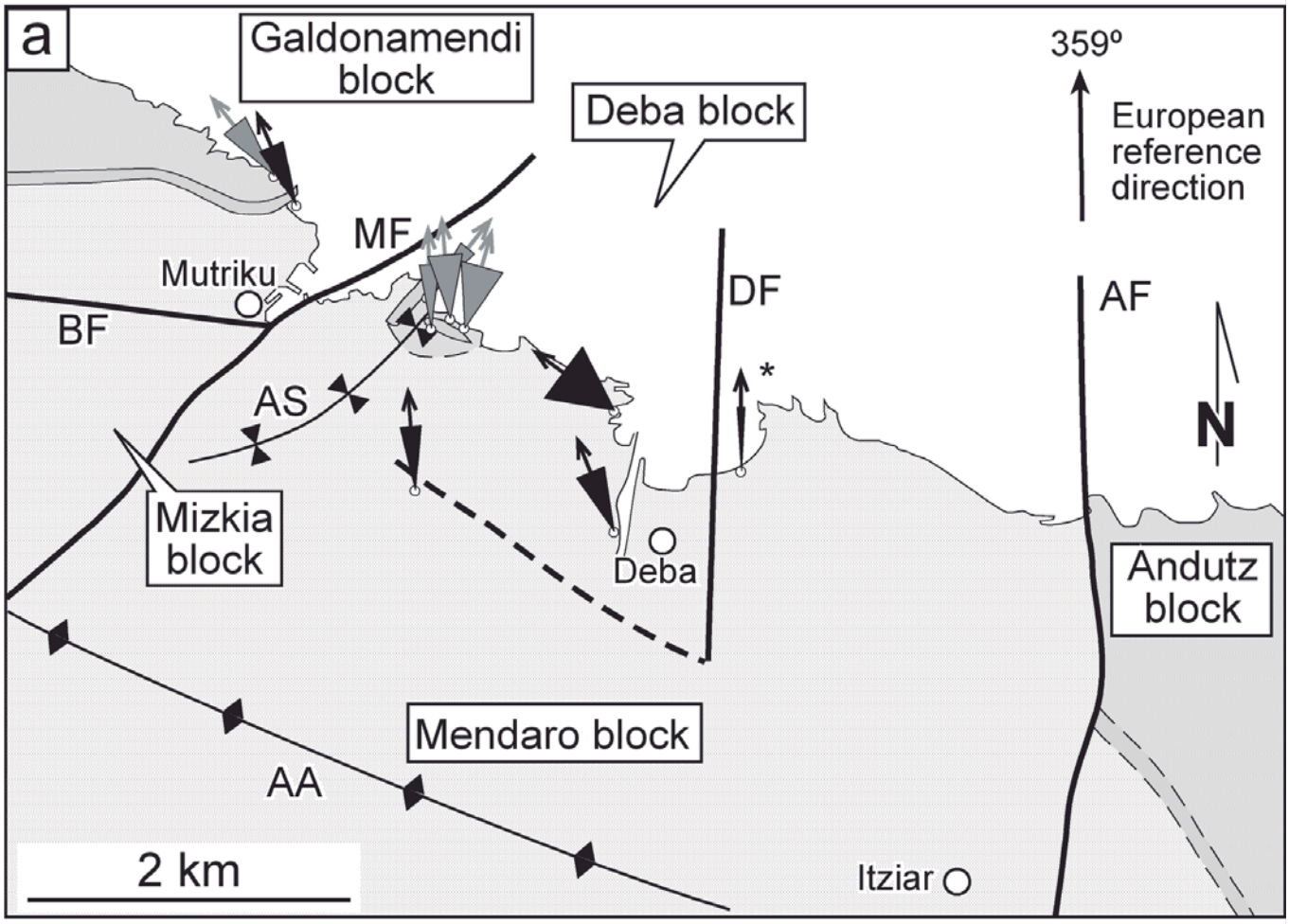


Fig. 2.- Obtained data from the study area. a) Paleomagnetic declination data (mean values); b) Paleocurrent data.

Fig. 2.- Datos obtenidos en el área de estudio. a) Datos de declinaciones paleomagnéticas (valores medios); b) Datos de paleocorrientes.

confining tectonic structures (N40E and N110-120E) (e.g. Agirrezabala and García-Mondéjar, 1994; Agirrezabala, 1996). One of these confining structures corresponds to the Mutriku fault and associated Aitzeta monoclinal syncline.

Detailed stratigraphic, sedimentologic and structural data and very accurate, ammonite-based dating of syntectonic deposits associated with the Aitzeta monoclinal syncline allow us to characterise the evolution of this structure. The Aitzeta structure constitutes a deep-water, fault-related transpressive fold that grew during ~1.3 My, Late Albian *auritus* Subzone, on the footwall of the right-hand reverse Mutriku fault. Two-phase growth caused overturning and denudation of the fold limb adjacent to Mutriku fault (Agirrezabala *et al*., 2002, 2003).

Data collection

A total of 80 samples for paleomagnetic study were collected from 9 sites corresponding to the Black Flysch Group deposits (lutites and siderites); 4 of them are made up of pre-*auritus* rocks and 5 of post-*auritus* rocks (Fig. 2a). Besides our new data, Vandenberg's (1980) datum from the Deba locality has been considered.

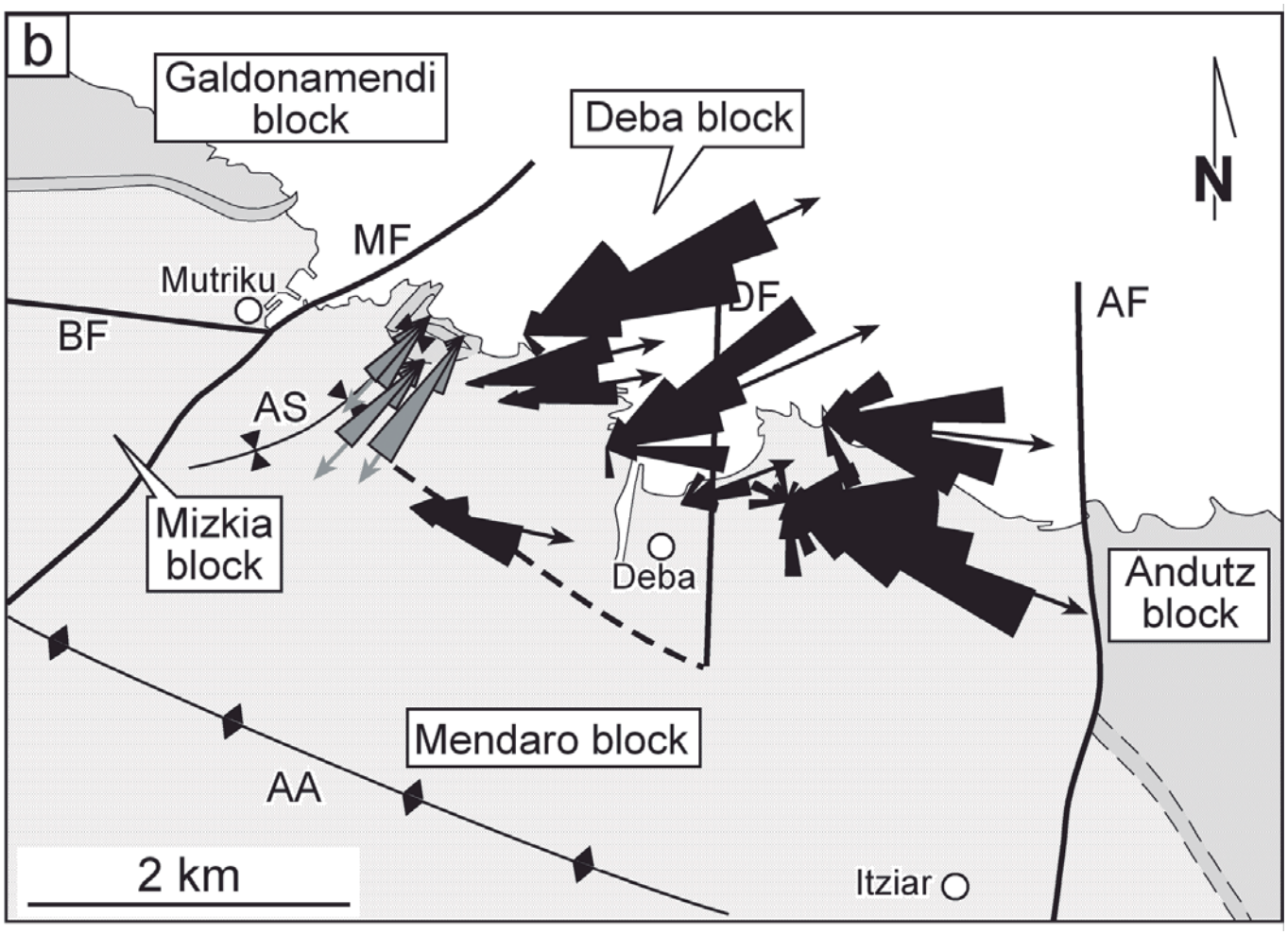
A total of 220 paleocurrents distributed at 11 sites were measured from sole mark structures (flute, prod, groove, bounce, crescent, skip casts). They were collected from both pre- and post-*auritus* sandstone turbidites to the east of the Mutriku fault (Fig. 2b).

Structural data supporting block rotations are mainly based on geological maps of 1:25.000 (Agirrezabala 1996; Agirrezabla *et al.*, 2002) and 1:5000 scales (inedit).

Results and conclusions

Obtained data (Fig.2) support Late Albian *auritus* Subzone and Tertiary (?) vertical-axis rotations based on three criteria: a) deviations of paleomagnetic declination data from the Albian European reference direction (N359E); b) anomalous paleocurrent data with respect to the Albian «normal» paleocurrents (N110E and N220E); and c) discordant tectonic structures with the main structural trend (N120E). Consistent results combined with a detailed stratigraphic framework allow reconstruction of the complex structural and depositional history of the area:

1) Late Albian pre-*auritus* Subzone (>102.2 My): Turbidity currents flowed east-southeastward («normal» paleocurrents). Submarine highs (Galdonamendi block and Arno anticline) controlled confined flows.
2) Late Albian *auritus* Subzone (102.2-100.9 My): Deba block rotated ~27º counterclockwise and the Aitzeta fold grew (Agirrezabala *et al.*, 2002). Rotation is indicated by both pre-*auritus* paleomagnetic declinations and paleocurrents of the Deba block, which shows similar deviations from



paleomagnetic reference and «normal» paleocurrents, respectively. Overlying unrotated post-*auritus* (*rostratum* Sbz.), paleomagnetic declinations and «normal» paleocurrents postdate *auritus* Sbz. rotation.

3) Late Albian *M. rostratum* Subzone (100.9-100.2 My): Turbidity currents flowed south-southwest («normal» paleocurrents) suggesting their partial unconfinement by disappearing or burial of the southern structural high (Arno anticline).
4) Tertiary (?): Galdonamendi and Mizkia blocks underwent counterclockwise rotations of ~27º and ~55º, respectively, and Andutz block rotated ~40º clockwise. Both Late Albian pre- and post-*auritus* paleomagnetic declinations in the Galdonamendi block show ~27º counterclockwise deviation from reference direction; very similar rotation degrees are also deduced from the discordant structural trend of that block with respect to the overall Tertiary (?) structural trend, as shown in the geological map. Similarly, in the cases of the Mizkia and Andutz blocks, the geological map shows Tertiary (?) fold traces discordant with respect to the general structural trend, inferring rotations of ~55º counterclockwise and ~40º clockwise, respectively. Deduced opposite rotations are interpreted as a result of northeastward displacement of the unrotated Mendaro and Deba blocks and the dragging of adjacent blocks (Galdonamendi, Mizkia and Andutz). On the other hand, paleomagnetic datum from the northwest limb of the Aitzeta monoclinal syncline (AS) shows a spurious rotation due to the conical character of the fold. Based on a nomogram of apparent rotations associated with conical folds from Pueyo *et al.* (2003), a spurious clockwise rotation of 26º is deduced for this site.

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References

Agirrezabala, L.M. (1996). *El Aptiense-Albiense del Anticlinorio Nor-Vizcaíno entre Gernika y Azpeitia*. Unpublished PhD. Thesis, Euskal Herriko Unibertsitatea, 429 p.

Agirrezabala, L.M. and García-Mondéjar, J. (1994). *Sedimentology*, 41, 383-407.

Agirrezabala, L.M., Owen H.G. and García-Mondéjar, J. (2002). *Geological Society of America Bulletin*, 114 (3), 281-297.

Agirrezabala, L.M., Owen H.G. and García-Mondéjar, J. (2003). *Geological Society of America Bulletin*, 115 (6), 765-768.

Choukroune, P. and Mattauer, M. (1978). *Bulletin de la Société Géologique de France*, ser. 5, 20, 689-700.

Pueyo, E.L., Parés, J.M., Millán, H. and Pocovi, A. (2003). *Tectonophysics*, 362, 345-366.

Souquet, P., Debroas, E.J., Boirie, J.M., Pons, P., Fixari, G., Roux, J.C., Dol, J., Thieuloy, J.P., Bonnemaison, M., Manivit, H. and Peybernes, B. (1985). *Bulletin Centres Rech. Explor.-Prod. Elf-Aquitaine*, 9 (1), 183-252.

Vandenberg, J. (1980). *Geologie in Mijnbouw*, 59 (1), 49-60.